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Reclamation Investigation and Expanded Engineering Evaluation and Cost Analysis

Spring Meadow Lake Site Helena, Montana



Prepared for:

**Montana Department of Environmental Quality
Mine Waste Cleanup Bureau**

Helena, Montana

Prepared by:

Tetra Tech EM Inc.

Helena, Montana

January 2006





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HELENA, MONTANA**

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1.0 INTRODUCTION

The Spring Meadow Lake site is located along Highway 12 West (Euclid Avenue) on the western edge of Helena, Montana. The site consists of portions of Spring Meadow Lake State Park and the Montana Department of Fish, Wildlife and Parks' (FWP) Montana Wildlife Center. The Montana Wildlife Center is located north of Highway 12 and south of Spring Meadow Lake (Figure 1-1). Spring Meadow Lake was formed by the excavation of sand and gravel by the former Helena Sand & Gravel Company. The lake consists of an oval-shaped main lake connected to a circular-shaped north arm and an irregularly shaped east arm.

The Montana Wildlife Center portion of the site (2650 Euclid Avenue) is located on a flat lying lot overlooking the lake area. Buildings on the site were constructed in 1892 by the John Stedman Foundry and Machine Company, and housed those operations through 1901. The Western Improved Wire Fence Company of the United States of America next occupied the complex, but its tenure was short-lived and the site was abandoned in 1910. The Northwestern Metals Company acquired the site that year and installed a mill to process ore using the Baker-Burwell method. This operation went into bankruptcy in 1915 and the property was taken over by the New York – Montana Testing and Engineering Company in 1916. This company handled testing and milling of gold-silver and manganese ores. It was also unsuccessful and closed in 1920. In the late 1920s, George F. Jacoby and his partner Thomas Brownlow obtained the site and the adjacent land and opened a gravel pit north of the old foundry mill complex under the name Helena Sand and Gravel. This operation lasted until the late 1950s.

Subsequent use of the land has involved additional gravel pit operation, a construction business headquarters, and land speculation.

1.1 PURPOSE OF RECLAMATION INVESTIGATION AND EVALUATION REPORT

The Spring Meadow Lake site consists of approximately 20 acres of mineral processing impacted lands. Four distinct waste areas and potential contaminated media (surface water contamination, surface soil contamination, subsurface soil contamination, and sediment contamination) are present at this site. Based on the Site Inspection and Hazardous Material Inventory completed by Montana Department of Environmental Quality, Mine Waste Cleanup Bureau (DEQ/MWCB) (2004), approximately 10,000 cubic yards (CY) of tailings and other mineral processing wastes are located within the site boundary, including at least one subsurface pit or sump with wet tailings. Contaminated sediments were also identified within



Spring Meadow Lake along the southern shore of the main lake and the southern portion of the east arm of the lake. Two water samples (SW-110 and SW-112), collected from the southern portion of the east arm of the lake had arsenic and manganese concentrations above water quality standards (Montana DEQ 2004). In addition, one water sample (SW-109) from the southern portion of the main Spring Meadow Lake had arsenic above the water quality standard. The DEQ/MWCB has decided to prepare a Reclamation Investigation (RI) and Expanded Engineering Evaluation and Cost Analysis (EEE/CA) report to address environmental impacts associated with the disposal of the former mineral processing wastes associated with the Spring Meadow Lake Site.

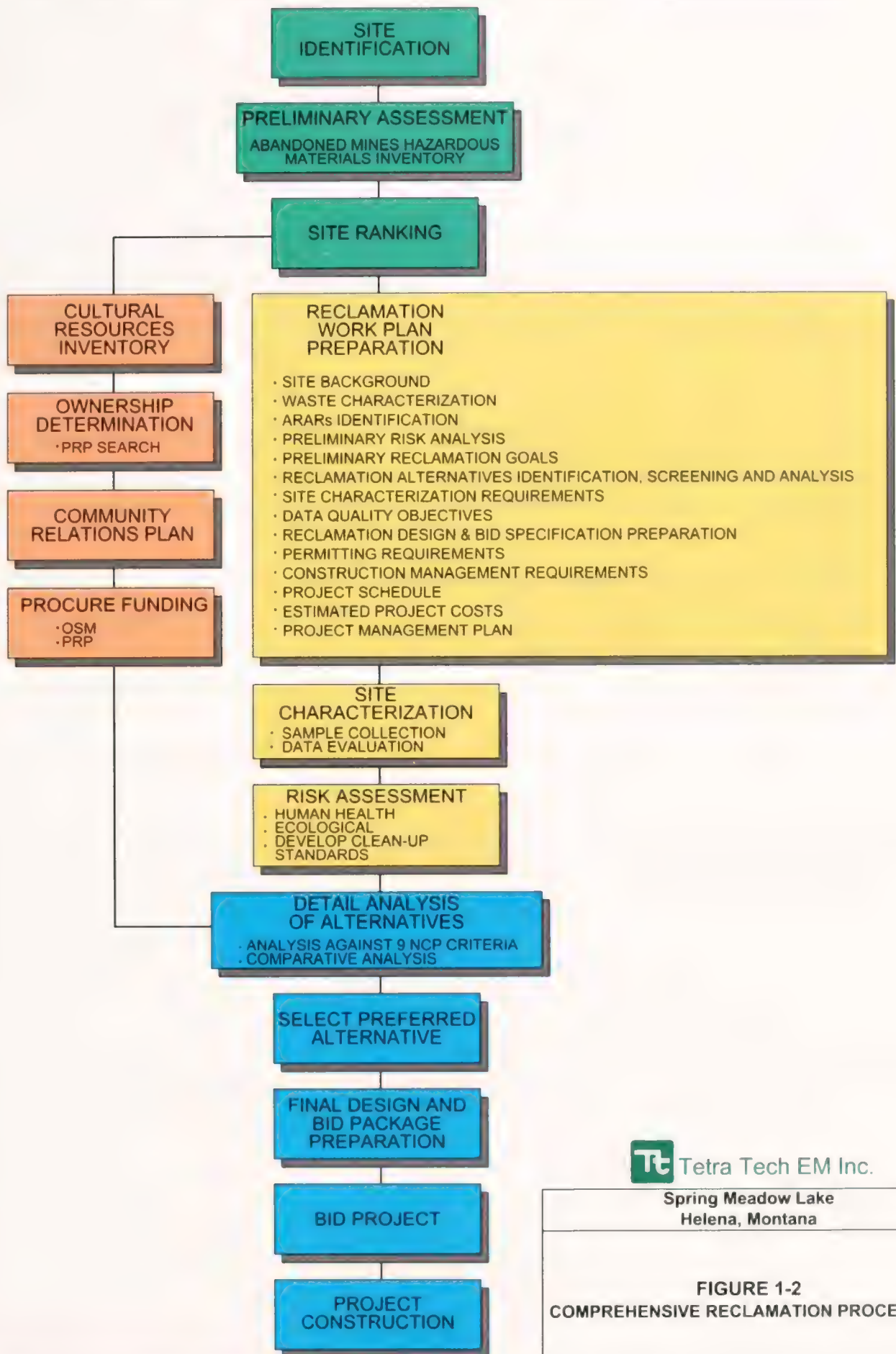
The RI and EEE/CA report has been prepared as a functional guide for conducting full-scale reclamation at the Spring Meadow Lake site. The reclamation activities proposed for the project site were developed as part of a comprehensive reclamation procedure (Figure 1-2). This reclamation procedure complies with the requirements of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and the Montana Comprehensive Environmental Cleanup and Responsibility Act (CECRA). The procedure streamlines certain aspects of the process to meet the regulatory requirements to clean up abandoned mine sites.

1.2 ORGANIZATION OF INVESTIGATION

Existing data available for the Spring Meadow Lake site have been evaluated and permission from owners to access property has been obtained by DEQ. The Reclamation Investigation and Evaluation Report is organized into six sections. The references are presented at the end of each section, which document the publications and materials used in the preparation of these sections. The contents of each section are briefly described below.

Section 1.0 Introduction - This section presents the purpose, organization, and management of the Spring Meadow Lake site RI and EEE/CA.

Section 2.0 Environmental Setting - This section describes the location of the Spring Meadow Lake site, including (1) climatic, geologic, and hydrologic characteristics of the site; (2) the biological setting such as the wildlife resources and the vegetation indigenous to the area; (3) threatened and endangered species concerns; and (4) present land uses and local population.



Tt Tetra Tech EM Inc.

Spring Meadow Lake
Helena, Montana

FIGURE 1-2
COMPREHENSIVE RECLAMATION PROCEDURE

Section 3.0 Description of Property - This section presents a summary of past mineral processing activities and the results of any past sampling and characterization at the site. The estimated types, volumes, and contaminant concentrations from existing data are provided. Ownership information and cultural issues are also provided in this section.

Section 4.0 Reclamation Work Plan - This section presents the reclamation work plan for the Spring Meadow Lake site, including (1) preliminary reclamation objectives and goals; (2) the field sampling plan; (3) the quality assurance protocol plan; (4) the laboratory analytical plan; and (5) the health and safety plan.

Section 5.0 Reclamation Investigation - This section presents the results of the reclamation investigation field activities, including (1) site and waste characterization; (2) reclamation and land use characterization; (3) human health risk assessment; (4) ecological risk assessment; and (5) conclusions.

Section 6.0 Expanded Engineering Evaluation and Cost Analysis - This section presents a detailed analysis of reclamation alternatives that regulatory agencies can use for reclamation decision-making, including (1) reclamation objectives and goals; (2) applicable or relevant and appropriate requirements; and (3) the development and screening of reclamation alternatives.

1.3 PROJECT MANAGEMENT

The DEQ MWCB and Tetra Tech EM Inc. team of professionals working on the investigation and evaluation of the Spring Meadow Lake site is presented in Section 1.3.1. The preliminary schedule for completing tasks and submitting plans and reports is presented in Section 1.3.2.

1.3.1 Project Team

The successful completion of this project requires the continual cooperation between DEQ MWCB, FWP, and Tetra Tech EM Inc. personnel. The DEQ/MWCB, FWP, and Tetra Tech EM Inc. personnel working on this project are presented in Table 1-1.

TABLE 1-1
PROJECT TEAM
SPRING MEADOW LAKE SITE

Agency/Firm	Personnel	Project Title	Contact Information
Montana Department of Environmental Quality/Mine Waste Cleanup Bureau	Vic Andersen	Bureau Chief	841-5025
	John Koerth	Spring Meadow Lake Project Manager	841-5026
Montana Fish, Wildlife, and Parks	Paul Valle	Design and Construction Bureau Chief	841-4013
	Craig Marr	Park Manager	495-3270
	Stella Capoccia	Wildlife Education and Rehabilitation Center Director	449-1312
Tetra Tech EM Inc.	Chris Reynolds	Program Manager Quality Assurance Manager Field Laboratory Supervisor	442-5588
	J. Edward Surbrugg	Project Liaison/Project Manager	
	Joe Faubion	Field Team Leader	
	Matt Hulbert	Field Team Member	
	Laura Newman, P.E.	Field Team Member	
	Dan Shaffer	Field Team Member	
	Jessica Allewalt	Field Team Member	
	Gary Sturm, P.E.	Project Engineer	
	Aaron Cade	Technical Support Team Member	
	Alicia Stickney	Technical Support Team Member	

The responsibilities of the DEQ/MWCB, FWP, and Tetra Tech EM Inc. project team members are presented below.

Mine Waste Cleanup Bureau Personnel Responsibilities:

- **Bureau Chief** - The bureau chief administers all MWCB activities.
- **Project Manager** - The MWCB project manager will monitor the performance of the contractor, review and approve QA measures, and provide direction to the Tetra Tech EM Inc. project liaison, project manager, and field team leader.

Montana Fish, Wildlife, and Parks Personnel Responsibilities:

- **Design and Construction Bureau Chief** - The bureau chief will coordinate document reviews with MWCB.

- **Park Manager** – The park manager will coordinate field work schedules with MWCB, Montana Wildlife Center, and Tetra Tech EM Inc.
- **Wildlife Education and Rehabilitation Center Director** – The wildlife center director will manage on-site notification and check in responsibilities for Tetra Tech EM Inc. field personnel.

Tetra Tech EM Inc. Personnel Responsibilities:

Program Manager - The program manager will administer all project activities, staffing, and budgets.

- **Quality Assurance Manager** - The quality assurance manager will review all work products for technical quality and consistency.
- **Project Liaison** - The project liaison will coordinate project activities with the MWCB project manager.
- **Project Manager** - The Tetra Tech EM Inc. project manager will oversee project field activities and work products. The project manager/project liaison will keep the field team informed of all project activities.
- **Field Laboratory Supervisor** - The field laboratory supervisor will oversee field analytical activities and will coordinate with the project manager and field team leader to complete the field activities. The field laboratory supervisor will also coordinate data review, validation, and auditing requirements.
- **Field Team Leader** - The field team leader will oversee the field sampling activities and coordinate with the wildlife center director to schedule all field activities.
- **Field Team Members** - The field team members will assist the field team leader and field laboratory supervisor to complete the field activities.
- **Project Engineer** – The project engineer will have primary responsibility for completing the engineering evaluation and the development and screening of reclamation alternatives.
- **Technical Support Team Members** - The technical support team members will assist the Tetra Tech EM Inc. project manager to complete all work products.

1.3.2 Project Schedule

The preliminary project schedule is presented in Table 1-2. This schedule assumes that the work assignments and agency review proceed in a steady and continuous manner.

TABLE 1-2
PROJECT SCHEDULE
SPRING MEADOW LAKE SITE

Document Submittal and Task Completion	Date
Draft Reclamation Work Plan	February 11, 2005
Final Reclamation Work Plan	March 11, 2005
Reclamation Field Activities	Spring 2005
Draft Reclamation Investigation Report	May 20, 2005
Final Reclamation Investigation Report	June 24, 2005
Draft Expanded Engineering Evaluation/Cost Analysis Report	June 24, 2005
Final Expanded Engineering Evaluation/Cost Analysis Report	July 29, 2005

1.4 REFERENCE CITED

Montana Department of Environmental Quality – Mine Waste Cleanup Bureau (DEQ/MWCB), 2004. Abandoned Hard Rock Mine Priority Site Investigation and Hazardous Materials Inventory. Spring Meadow Site, Lewis and Clark County, PA 25-505. Completed by Tetra Tech EM Inc.

Montana DEQ. 2004. Montana Numeric Water Quality Standards (Circular WQB-7). January.

2.0 ENVIRONMENTAL SETTING

The environmental setting of the Spring Meadow Lake site is provided in the following sections (Section 2.1 through 2.7). The references cited in Section 2.0 are presented in Section 2.8.

2.1 SETTING

The Spring Meadow Lake site is located on the western edge of the Helena, Montana city limits (Figure 1-1). The Spring Meadow Lake is situated at an elevation of approximately 3,950 feet above mean sea level (amsl) in Section 23, Township 10 North, Range 4 West, Montana principle meridian (Latitude North 46° 36' 30"; Longitude West 112° 04' 30"). The Spring Meadow Lake site is comprised of approximately 20 acres of mineral processing impacted land along the south and east shorelines of Spring Meadow Lake. A general location and topographic view of the site is presented in Figure 1-1 and a detailed site map of the entire project area is provided in Figure 4-1 (see Section 4).

2.2 CLIMATE

The Spring Meadow Lake site is situated approximately 10 miles east of the Continental Divide at the western edge of the Helena Valley at an elevation of approximately 3,950 feet amsl. The main site lies in the valley of Tenmile Creek. The surrounding area consists of relatively flat floodplain to moderately sloped hillsides. The climate of the Spring Meadow Lake area is a modified continental climate similar to that of the Helena Valley. The cool air and general protection provided by the surrounding mountains contribute to less seasonal variation in temperature than would be typical of a true continental climate.

Climate information was obtained from the Western Regional Climate Center (WRCC) located at the Helena, Montana airport. Average monthly temperatures range from a high of 83°F to a low of 54°F in July and a high of 30°F to a low of 11°F in January. Average annual precipitation is roughly 12 inches a year. Average monthly precipitation exceeds 1 inch during May through September. The wettest months of the year are May and June. Precipitation is mostly in the form of snow in the winter months, snow and rain in the spring and fall, and rain in the summer.

2.3 GEOLOGY AND SOILS

The Spring Meadow Lake site is located within the Tenmile Creek floodplain, approximately ¼ mile southeast of the current Tenmile Creek channel. The site is underlain by sands and gravels from mixed igneous, limestone, and sandstone formations that were deposited by glacial outwash during the Pleistocene age (USDA-NRCS 2003). The alluvium parent materials for the soils that developed at this site have been influenced by historic Tenmile Creek channel locations and by local depositional areas. The depth of sand and gravel at this site is variable but the depth of Spring Meadow Lake is approximately 40 feet.

The soil mapped at the Spring Meadow Lake site is the Meadowcreek-Fairway complex, 0-2% slopes (USDA-NRCS, 2003). This soil is classified as a fine-loamy over sandy-skeletal, mixed Fluvaquent Haplustolls and formed in relatively recently deposited sediments. These soils typically have seasonally high ground water at 2 to 4 feet below the surface and occupy the lower positions on flood plains. The surface soil horizon has a loam to silt loam texture and may be about 10 to 15 inches thick. Subsurface horizons have loam to sandy loam textures in the upper parts, grading to a very gravelly sand at about 60 inches deep.

Nearly the entire Spring Meadow Lake site has been disturbed by past mineral processing and sand and gravel mining activities. In areas where there were no excavations, waste materials and common fill was deposited.

2.4 HYDROGEOLOGY

The Montana Bureau of Mines and Geology Groundwater Information Center (GWIC) database includes over 1,339 logs within a one-mile radius of the Spring Meadow Lake site. Most of these wells appear to be used to supply domestic water to surrounding residences.

Spring Meadow Lake was formed after sand and gravel mining ceased as groundwater inflows and surface water run-in filled the excavated pits. Helena Sand & Gravel Company ceased gravel mining operations in 1960. Spring Meadow Lake consists of an oval-shaped main lake connected to a circular-shaped north arm and an irregularly shaped east arm. The main lake is relatively deep with a reported depth of 40 feet. The east arm of the lake is shallow with a maximum depth of about five feet.

2.5 HYDROLOGY

The Spring Meadow Lake site is located within the floodplain of Tenmile Creek. Storm water runoff from the site and other areas south and east of the lake flows into the lake. Seasonal overflow from the lake drains north from the east arm and flows into wet areas north and west of the Lewis and Clark County Fairgrounds and east of the Green Meadow Country Club.

2.6 VEGETATION AND WILDLIFE

The Spring Meadow Lake site has areas with all stages of vegetation from manicured grass to bare ground. The State Park portion has grassed areas around the swimming portion of the lake, and riparian vegetation around the remainder of the lake perimeter. Numerous willow, cottonwood, speckled alder, and Russian olive trees have become established during the last 45 years. Native and introduced grasses are found growing on most areas of the site, including inland saltgrass, western wheatgrass, thickspike wheatgrass, needle-and-thread grass, smooth brome grass, and annual brome grass. Other shrubs and forbs are found in selected areas and include western snowberry, wild rose, yellow sweetclover, babysbreath, and spotted knapweed.

The Spring Meadow Lake site provides habitat for fish and other aquatic organisms, rabbits, rodents, and reptiles. Some white-tailed and mule deer may use the south end of the site on occasion. Many species of birds are found around the site throughout the year. No threatened or endangered species are known to frequent the area (Natural Heritage Program 2005).

2.7 LAND USE AND POPULATION

The Spring Meadow Lake site is located within the city limits of Helena, Montana. Helena is an incorporated city with an estimated population of 26,000 (U.S. Census Bureau 2000). The primary land uses in the area include recreational, residential, and light commercial.

2.8 REFERENCES CITED

- Groundwater Information Center (GWIC). 2003. "Well Log List in T10N, R4W, Section 23, with a 1-Mile Buffer." Accessed on March 24, 2004. On-Line Address: <http://mbmaggwic.mtech.edu>
- Natural Heritage Program. 2005. Database search for plant and animal species of special concern, Montana Natural Resource Information System, Montana State Library. March 4.

U.S. Census Bureau. 2000. "2000 U.S. Census Estimate".

U.S. Department of Agriculture, Natural Resources Conservation Service (USDA-NRCS). 2003. Soil Survey of Lewis and Clark County Area, Montana, Part 1 and 2.

Western Regional Climate Center (WRCC). 2005. "Helena, Montana Period of Record Monthly Climate Summary." Accessed on January 28, 2005. On-Line Address:
<http://www.wrcc.dri.edu/summary/climsmmt.html>

3.0 DESCRIPTION OF THE PROPERTY

The Spring Meadow Lake site is comprised of approximately 20 acres of land that has been impacted by past mineral processing and sand and gravel mining. The site consists of portions of Spring Meadow Lake State Park and the Montana Department of Fish, Wildlife, and Parks (FWP) Montana Wildlife Center. The history of the Spring Meadow Lake site is provided in Section 3.1. Section 3.2 presents a description of the current property, including site waste characteristics and historical features. Section 3.3 presents information about the two State-owned uses for the Spring Meadow Lake Site. The references cited in Section 3.0 are provided in Section 3.4.

3.1 SPRING MEADOW LAKE SITE HISTORY

Renewable Technologies, Inc. (RTI) is currently in the process of completing a detailed historical review for the Spring Meadow Lake site for the Montana DEQ/MWCB. RTI prepared a preliminary historical summary for the site that is the source for the following information (RTI 2005).

The first industrial use of the project area dates to 1892 when the Stedman Foundry and Manufacturing Company opened a foundry. Workers erected three stone buildings to house the complex and a variety of iron products were produced, presumably for local use. In 1901 the business folded due to insufficient funds. The Western Improved Wire Fence Company of the United States of America was the next site occupant, but its tenure was also short-lived and it abandoned the site by 1910.

The Northwestern Metals Company acquired the Stedman Foundry property in 1910 and installed a mill to process ore from its Comet, Bullion, and Crystal mine group in the Cataract Creek drainage basin south of Wickes, Montana. The 1,000-ton capacity mill employed the Baker-Burwell process which was said to work well on ores with high zinc content. Due to processing inefficiencies, however, the operation went into bankruptcy in 1915.

The New York - Montana Testing and Engineering Company formed circa 1916 and took over the Stedman Foundry property. Having both testing and milling equipment, the management handled gold-silver and manganese ores. It received manganese shipments from the Ophir Mine in Butte and unnamed Philipsburg mines, as well as material from the Valley Forge dumps near Rimini and possibly the Liverpool Mine in the Clancy district. This endeavor also was unsuccessful in the long-term, closing in 1920.

The facility presumably stood vacant for several years until the late 1920s when George F. Jacoby acquired it and the adjacent land. Jacoby and his partner Thomas Brownlow, using the name Helena Sand and Gravel, opened a gravel pit north of the old foundry and mill complex. They stored and repaired equipment in the stone buildings, two of which still stand today. Their sand and gravel operation expanded to include a ready-mix plant and remained in operation at the site until the late 1950s. Although the disposition of tailings from the earlier ore milling operations was not recorded in the sources consulted, it seems likely that some portion of the tailings on the property were removed during the Helena Sand and Gravel operations.

Since 1960, the Stedman Foundry property and associated excavated gravel pit have been used as an additional gravel pit operation, a construction business headquarters, and for land speculation. The Montana FWP first acquired land in the Spring Meadow Lake Park area in 1981.

3.2 DESCRIPTION OF THE CURRENT PROPERTY

For investigative purposes, the Spring Meadow Lake site has been divided into two areas based on the differing management divisions of the State Park and the Montana Wildlife Center. The State Park area consists of the developed State Park built around the former excavated sand and gravel pits. The State Park area also includes the east arm of Spring Meadow Lake that is nearly continuously ponded by the current water table elevation. Some portions of the east arm are seasonally dry when the water level of Spring Meadow Lake drops (winter time mostly).

The Montana Wildlife Center portion of the Spring Meadow Lake site was the original Stedman Foundry property that was also used as a custom leaching mill, floatation mill for gold-silver and manganese ores, and a facility area for gravel mining operations. During the sand and gravel mining period (1920 to 1960), the Montana Wildlife Center area likely housed the sand and gravel stockpiles, staging areas, and business offices. One of the old stone and wood buildings burned substantially in December of 2003. The remaining stone walls and concrete floor were demolished and hauled offsite in early 2004 and the area has been regraded. The Montana Wildlife Center has built several new chain-link fenced pens and shelters for wildlife. The Montana Wildlife Center opened in March 2004 and is currently operational.

3.2.1 Waste Characteristics

Tetra Tech EM Inc. completed a site inspection and hazardous materials inventory for DEQ MWCB in 2004 (DEQ/MWCB 2004). As part of this inspection and inventory, Tetra Tech EM Inc. collected 81 soil samples from 29 backhoe pits; 26 soil samples from surface and shallow subsurface soil pits; 10 co-located sediment and water samples from the perimeter of Spring Meadow Lake; and 2 lake water samples from Spring Meadow Lake swimming areas where sand had been imported to cover the lake bottom. A field portable x-ray fluorescence (XRF) instrument was used to analyze for total metals in all soil samples following Method 6200 - Field Portable X-ray Fluorescence Spectrometry for the Determination of Elemental Concentrations in Soil and Sediment (U.S. EPA, 1998). Twenty of the total 107 soil samples were also submitted to an offsite laboratory for total metals analysis by inductively coupled plasma – atomic emission spectrometry (ICP-AES) for 13 target metals.

The metals in the soil samples were dissolved from the matrix into an aqueous solution by acid digestion as described in Method 3050B - Test Methods for Evaluating Solid Waste, Physical Chemical Methods” (EPA 1996). This digestion method involves a combination of nitric and hydrochloric acids plus the addition of hydrogen peroxide to assist in degrading organic matter in the samples. Method 3050B digestion is not a “total” digestion, but is instead a solubilization of “environmentally available” metals and may have values lower than total metals concentrations determined by XRF analysis.

ICP-AES metals analysis (Method 6010B) was used to determine the target metals concentrations in all soils, sediments, and water samples. The ICP-AES technique is a widely available metals analysis for samples that may have wide ranging metals concentrations and other matrix interferences.

The analytical results of the metals analyses are presented in Table 3-1. Approximately 10,000 cubic yards of tailings and other mineral processing wastes were identified within the site, including at least one subsurface pit or sump full of wet tailings. Contaminated sediments also were identified within Spring Meadow Lake along the southern shore of the main lake and the southern portion of the east arm of the lake.

**TABLE 3-1: HISTORIC LABORATORY ANALYTICAL RESULTS
SPRING MEADOW LAKE SITE**

Sampling Entity	Sample Date	Sample ID	Sample Media	Units	Depth (ft)	Arsenic	Copper	Manganese	Lead	Zinc
Chris Harada Carroll College ^a	7/2002	A4	Sediment	ppm	----	----	30	----	100	50
		A5			----	----	125	14,000	1,000	240
		A6			----	----	200	19,000	2,700	330
		A7			----	----	85	500	250	70
		B1			----	----	55	----	200	20
		B2			----	----	190	12,000	4,000	520
		B3			----	----	90	----	400	50
		B4			----	----	60	----	200	30
		B5			----	----	95	3,500	500	80
		B6			----	----	80	1,000	300	50
		B9			----	----	220	15,500	3,000	340
Montana FWP	5/2003	C0307-2203	Trout	µg/g ^b	----	<20	<2	<2	<10	22
		C0307-2204	Bass			<20	<2	<2	<10	39
	8/2003	C0308-3413	Water	mg/l	----	0.020	<0.002	0.017	<0.005	<0.005
		C0308-3414				0.020	<0.002	0.005	<0.005	<0.005
		C0308-3415				0.190	<0.002	1.410	<0.005	<0.005
Montana DEQ	4/2004	C0312-4988	Solid Matrix	mg/kg	----	0.017	0.002	0.013	<0.005	<0.005
		SF1				9,070	487	1,160	69,900	5,450
		SF2				<100	300	463,000	2,030	6,340
		SF3				<100	184	255,000	1,210	7,550
Tetra Tech EM Inc.	7/2004	TP 104	Solid Matrix	mg/kg	1	2,910	224	27,300	2,410	3,700
					1.2	2,640	240	34,400	2,320	3,600
		TP 106			1	20,700	220	8,290	5,220	4,240
		TP 107			4	27,700	1,390	21,000	39,000	18,000
					5	1,250	505	228,000	2,730	7,940
		TP 109			12	57,500	3,300	949	28,600	29,700
		TP 111			2	34,200	905	1,370	23,100	10,900
		TP 113			1	451	175	1,410	819	4,180
		TP 115			2	5,890	516	43,700	4,260	2,150
		TP 116			4.5	951	83	24,500	915	1,000
		TP 119			1	8,980	443	111,000	5,840	6,020
		TP 120			1	2,920	390	220,000	2,480	5,580
					3	222	424	191,000	1,970	4,280
		TP 126			2	3,280	232	120,000	1,920	4,120
		TP 127			2	1,240	95	16,800	690	1,710
					4	163	41	1,250	95	172
		SS 204			0.5	302	108	6,180	468	1,010
		SS 206			0.1	2,430	327	176,000	2,160	5,020
		SS 207			0.1	2,200	312	170,000	2,120	4,310
		SS 216			0.5	1,520	210	70,100	1,340	2,640
		SD 101	Sediment	mg/kg	----	13	14	349	48	78
		SD 102			----	<10	16	293	79	88

TABLE 3-1: HISTORIC LABORATORY ANALYTICAL RESULTS (Continued)
SPRING MEADOW LAKE SITE

Sampling Entity	Sample Date	Sample ID	Sample Media	Units	Depth (ft)	Arsenic	Copper	Manganese	Lead	Zinc
Tetra Tech EM Inc.	7/2004	SD 103	Sediment	mg/kg	----	<10	<10	237	31	38
		SD 106				<10	<10	136	16	25
		SD 107				10	24	155	14	25
		SD 108				<10	33	193	39	37
		SD 109				136	112	628	105	310
		SD 110				2,130	156	48,800	1,480	2,280
		SD 111				12	15	278	38	76
		SD 112				726	96	25,000	1,030	1,150
		SW 101	Water	mg/l	----	0.009	<0.001	0.017	<0.003	0.010
		SW 102				0.017	<0.001	0.007	<0.003	0.010
		SW 103				0.017	<0.001	<0.005	<0.003	<0.01
		SW 104				0.017	<0.001	0.010	<0.003	<0.01
		SW 105				0.017	<0.001	0.010	<0.003	<0.01
		SW 106				0.016	<0.001	0.007	<0.003	<0.01
		SW 107				0.017	<0.001	0.008	<0.003	<0.01
		SW 108				0.017	<0.001	0.009	<0.003	<0.01
		SW 109				0.019	<0.001	0.009	<0.003	<0.01
		SW 110				0.240	0.001	0.380	<0.003	<0.01
		SW 111				0.017	<0.001	0.011	<0.003	<0.01
		SW 112				0.020	0.001	0.066	0.005	0.020

Notes:

^a	Concentrations were estimated from bar graphs
^b	Dry weight values reported for fish samples
ft	feet
µg/g	micrograms per gram
mg/kg	milligrams per kilogram
mg/l	milligrams per liter

The previous laboratory analytical results from the Carroll College, DEQ, and PA data (DEQ MWCBS 2004) indicate that the mineral processing wastes found at several locations on the Spring Meadow Lake site contain arsenic, manganese, and lead concentrations higher than background levels and at concentrations in the solid matrix materials above the recreational cleanup levels (50-day rock-hound/gold panner scenario) that may be applicable for assessing risks for human health (Tetra Tech 1996). The human health and ecological risk assessments will be completed as part of the RI for this site using both qualified historic analytical results and analytical results acquired during the completion of the RI.

The previous analytical results indicate that the sediments in the east arm of Spring Meadow Lake contain concentrations of arsenic, copper, manganese, lead, and zinc above freshwater sediment quality levels

(Washington State Department of Ecology 1997). Additional sediment sampling and analysis will be completed during the RI for this site. Sediment metal concentrations and cleanup levels will be evaluated during the ecological risk assessment portion of the RI. The Montana FWP collected five small-mouth bass and five rainbow trout in May 2003. One composite trout sample and one composite bass sample was prepared from the five fish and analyzed for metals. This fish data will be included in the ecological risk assessment to be completed during the RI.

The previous analytical results indicate that three water samples collected in Spring Meadow Lake contain arsenic concentrations above the numeric water quality standard for human health (0.018 milligrams per liter [mg/L]) (Montana DEQ 2004). In addition, two Spring Meadow Lake water samples contain manganese concentrations above the secondary standard (0.050 mg/L). This standard is based on effects on beneficial use of the water due to taste, odor, and staining.

3.2.2 Significant Historical and Cultural Features

On September 11, 1995, the Montana State Preservation Review Board approved the nomination of the Stedman Foundry and Machine Shop to the National Register of Historic Places. The site was placed on the National Register of Historic Places on April 4, 1996.

3.3 OWNERSHIP INFORMATION

The State of Montana purchased the State Park portion of the property from Reber Realty & Development in 1981 and the Montana Wildlife Center property from Walter and LaDonna Bell in 1995. Although both portions are owned by the State of Montana Department of FWP, they are managed under two separate Divisions within the agency. The lake portion of the site is managed by the Parks Division while the Montana Wildlife Center is under the Conservation Education Division. The mineral processing wastes associated with the Spring Meadow Lake site are found on both the Spring Meadow Lake State Park and the Montana Wildlife Center properties.

3.4 REFERENCES CITED

DEQ/MWCB, 2004. Abandoned Hard Rock Mine Priority Site Investigation and Hazardous Materials Inventory. Spring Meadow Site, Lewis and Clark County, PA 25-505. (Tetra Tech EM Inc.)

Montana DEQ. 2004. Montana Numeric Water Quality Standards (Circular WQB-7). January.

- Renewable Technologies, Inc. (RTI). 2005. Historical Information for the Spring Meadow Lake Site. Emailed communication from RTI to Mr. John Koerth, Project Manager at DEQ/MWCB, February 16.
- Tetra Tech, Inc. 1996. "Risk Based Cleanup Guidelines for Abandoned Mine Sites: Final Report." Prepared for the Department of Environmental Quality, Abandoned Mine Reclamation Bureau. February.
- U.S. Environmental Protection Agency (EPA). 1996. Method 3050B - Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, USEPA SW 846, U.S. Gov. Print. Office, Washington, DC.
- EPA. 1998. Method 6200 - Field Portable X-ray Fluorescence Spectrometry for the Determination of Elemental Concentrations in Soil and Sediment, USEPA SW 846, U.S. Gov. Print. Office, Washington, DC.
- Washington State Department of Ecology. 1997. Creation and Analysis of Freshwater Sediment Quality Values in Washington State. Publication No. 97-323a. Department of Ecology Publications Distributions Office. Olympia, Washington. July.

4.0 RECLAMATION WORK PLAN

The Montana DEQ/MWCB has requested that Tetra Tech EM Inc. prepare a reclamation work plan that includes a field sampling plan (FSP), a quality assurance protocol plan (QAPP), a laboratory analytical plan (LAP), and a health and safety plan. This reclamation work plan has been prepared as a functional guide for conducting full-scale reclamation at the Spring Meadow Lake site. The four supporting plans are presented in Sections 4.2 through 4.5. The references cited in Section 4.0 are presented in Section 4.6.

4.1 PRELIMINARY RECLAMATION OBJECTIVES AND GOALS

The preliminary reclamation objectives and goals for the Spring Meadow Lake site are discussed in the following sections.

4.1.1 Preliminary Reclamation Objectives

The overall objective of the Spring Meadow Lake site reclamation project is to protect human health and the environment in accordance with the guidelines set forth by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). Specifically, site reclamation must limit human and ecological exposure to mineral processing-related contaminants and reduce the mobility of those contaminants through associated solid media, sediment, groundwater, and surface water exposure pathways. The final reclamation objectives, including the specific amount of contaminant exposure and mobility reduction required, will be determined after site characterization, risk assessment, and analysis of the applicable or relevant and appropriate requirements are completed.

4.1.2 Preliminary Reclamation Goals

Preliminary remediation goals (PRG) are contaminant-specific and media-specific numbers that reflect potential cleanup levels at the Spring Meadow Lake site. PRGs have been established for the Spring Meadow Lake site to guide investigation activities and to identify areas and media that may require reclamation. Water and solid matrix (soil and sediment) PRGs for the Spring Meadow Lake site are shown in Table 4-1 and Table 4-2, respectively. PRGs may be based on Federal and State water quality standards, sediment quality screening values, or on risk-based concentration values. Federal and State water quality standards used to evaluate surface water and groundwater data include maximum contaminant levels (MCL), non-zero maximum contaminant level goals (MCLG), freshwater chronic

aquatic life standards (CALS), and Montana human health standards (HHS) for water. Sediment quality values are derived from the probable apparent effects thresholds (PEAT) from bioassay studies in Oregon and Washington State (Washington State Dept. of Ecology). Risk-based PRGs or cleanup guidelines have been developed by the U.S. Environmental Protection Agency (EPA) Region 9 and by Montana DEQ. The risk-based numbers are calculated for different contaminants and the recreational visitor exposure pathway using standard EPA risk assessment methodology. The following sections present the water quality standards for surface water, the freshwater sediment quality values from Washington State, and the risk-based concentrations for soil.

Surface Water

Surface water in Spring Meadow Lake originates primarily from groundwater inflow. The lake water level does fluctuate seasonally with the irrigation of cropland near the site and with the surface water flows in nearby Tenmile Creek. Surface water runoff from the Montana Wildlife Center property and surrounding areas of Spring Meadow Lake also flows into the lake. Seasonal overflows from Spring Meadow Lake are discharged from the northeast corner of the lake and flow northerly into wetland areas associated with the Green Meadow Country Club and Crystal Springs Creek.

Previous analyses of the surface water indicated elevated arsenic and manganese concentrations. Arsenic is a human health contaminant of concern and manganese may affect the beneficial uses of the water. The historical surface water sampling results are presented in Section 3.2.1. Table 4-1 presents the surface water PRGs for metals of concern.

Solid Matrix Materials

Analysis of solid matrix samples (which include soils, mineral processing wastes, and sediments) collected during the site inspection and hazardous materials inventory (DEQ-MWCB 2004) indicates that the soils and mineral processing wastes contain concentrations of arsenic, manganese, and lead above background concentrations and at levels of potential concern. Analytical results from other solid matrix samples collected by the Montana DEQ and by a student at Carroll College indicate similar contaminants and concentrations above background. The historical solid matrix sampling results are presented in Section 3.2.1.

TABLE 4-1
PRELIMINARY RECLAMATION GOALS FOR SURFACE WATER (µg/L)
SPRING MEADOW LAKE SITE

Contaminant	CALS^a	HHS^b
Arsenic	150	18
Cadmium	1.429 ^c	5
Copper	5.2 ^c	1,300
Iron	1,000	300
Lead	3.2 ^c	15
Manganese	None	50
Zinc	67 ^c	2100

Notes:

- ^a CALS - Freshwater Chronic Aquatic Life Standards, Circular WQB-7, Montana Numeric Water Quality Standards (DEQ 2004)
- ^b HHS - Human Health Standards for Water, Circular WQB-7, Montana Numeric Water Quality Standards (DEQ 2004)
- ^c CALS assume water hardness of 50 mg/L for cadmium, copper, and zinc, and 100 mg/L for lead

Sediment samples collected during the site inspection and hazardous materials inventory (DEQ-MWCB 2004) indicate that concentrations of arsenic, manganese, lead, and zinc may be above sediment quality values (Washington State Dept. of Ecology 1997) and at levels of potential concern. There are currently no promulgated standards for metal concentrations in soil or sediment in Montana. To assist in investigation planning and reclamation option selection and development, EPA Region 9 has developed risk-based PRGs for metals in soil. In addition, the Montana DEQ has developed a conservative set of risk-based guidelines that are calculated for different contaminants using a recreational visitor exposure scenario. The guidelines take into account the possibility of exposure through multiple exposures. The PRGs are intended to help investigators plan reclamation actions but should not be used to determine site risks.

At other sites in Montana, the Montana DEQ has recommended the use of the freshwater sediment quality values published by the Washington State Dept. of Ecology (1997) for ecological screening levels. Action levels for soils and sediments at the Spring Meadow Lake site will be determined based on the results from the human health and ecological risk assessments completed during the RI. The PRGs for the metals of concern in soils and sediments are listed in Table 4-2.

TABLE 4-2

**PRELIMINARY RECLAMATION GOALS
FOR SOIL AND SEDIMENT (mg/kg)
SPRING MEADOW LAKE SITE**

Contaminant	EPA Region 9 Residential PRGs	Washington State Dept. of Ecology Freshwater Sediment Quality PAET Values ^a
Arsenic	0.39 (40) ^b	19
Manganese	1800	1400
Lead	400	240
Zinc	23,000	500

Notes:

mg/kg milligrams per kilogram

^a Probable Apparent Effects Threshold (PAET) Values: (Washington State Dept. of Ecology 1997)

^b 0.39 is the arsenic Region 9 Residential PRG for the carcinogenic endpoint. Montana DEQ uses a soil screening value of 40 mg/kg for arsenic based on background arsenic values for Montana soils.

4.2 FIELD SAMPLING PLAN

This FSP has been prepared as a guide for conducting the RI of the Spring Meadow Lake site. The FSP presents sampling objectives and procedures, field analytical procedures, sample documentation and custody procedures, sample preservation and handling requirements, and decontamination procedures.

The purpose of the RI is to collect the information necessary to perform the risk assessments, to complete an expanded engineering evaluation and cost analysis (EEE/CA), and to select a reclamation alternative. Once the reclamation alternative has been selected, site- and alternative-specific engineering data may need to be collected to support design efforts.

Data collected to support the human health and ecological risk assessments will include:

- the magnitude and extent of surface and subsurface soil contamination
- the magnitude and extent of sediment contamination
- the magnitude of surface water contamination
- metals concentration in background soil

Data collected to complete the EEE/CA will include:

- accurate estimates of the area and volume of solid waste material requiring reclamation
- data to determine if waste material is classified as a Resource Conservation and Recovery Act (RCRA) hazardous waste
- data to determine reclamation requirements for disturbed areas including soil texture and grain size, liming requirements, fertilizer requirements, percent organic matter, and identification of native species
- location and characterization of potential repository sites
- location of potential cover soil borrow area

4.2.1 Sampling Objectives

Surface soil, subsurface soil, and sediments with elevated metal concentrations are present at the Spring Meadow Lake site. Table 4-3 lists the sample type, analysis, approximate number of samples that will be required to fulfill the sampling objectives, and number of contingency samples. Figure 4-1 shows the approximate sampling locations. The sampling objectives for the Spring Meadow Lake site are:

- Determine the nature and extent of surface soil contamination. Samples will be collected to further define the approximate locations of the contaminated materials that were identified during the site inspection and hazardous materials inventory (DEQ-MWCB 2004). Up to 10 opportunistic surface soil grab samples will be collected within or near visually identified edges of the tailings and mineral processing waste areas. All samples will be sent to the laboratory for total metals analysis.
- Determine the nature and extent of subsurface soil contamination. The thickness of contaminated materials and waste sources was approximately defined during the site inspection and hazardous materials inventory (DEQ-MWCB 2004). To provide more accurate calculations of the volume of materials that may require removal, 24 additional backhoe pits will be completed in and around the identified waste source areas. Assuming that an average of 2 samples are collected at each backhoe pit, 48 subsurface soil samples will be collected and analyzed for total metals at an offsite laboratory.
- Determine the location and distribution of metal-contaminated sediments in the east arm and south end of Spring Meadow Lake site area. Eight sediment samples will be collected from the central areas of the east arm and from approximately 25 feet from the footbridge. Grab samples will be collected from a boat using a standard sediment sampling device (Ponar or coring tube). The sediment sampler will be lowered to the surface of the bottom sediment and opened up or rotated into the sediment. The sediment grab sampler is relatively easy to handle and operate, and generally provides high sample integrity. The sediment sampler can collect sediments to a depth of about 6 inches which should provide sufficient sample volume

for analysis. All sediment samples will be decanted and sent to an offsite laboratory for total metals and total organic carbon analysis.

- Determine the quality of surface water in the east arm of Spring Meadow Lake and at a representative background area within the Lake. Three surface water samples will be collected and sent to an offsite laboratory for analysis.
- Determine the quality of groundwater (metals) downgradient of the former mineral processing location and below the contaminated sediments near the east arm of Spring Meadow Lake to determine if metals have migrated from surface and subsurface soils to the groundwater at this site. Install two monitoring wells, develop wells, and collect groundwater samples for total metals analysis at an offsite laboratory.

4.2.2 Soil Sampling Procedures

Surface Soil

Up to 10 opportunistic surface soil grab samples will be collected within or near visually identified edges of the tailings and mineral processing waste areas. The method used to select the sample locations will be different for samples intended to characterize the mineral processing wastes (visual) compared to samples intended to characterize the extent of surface soil contamination (soil located a short distance away from a visual waste). Sample locations used to characterize the waste materials will be selected based on visible characteristics including soil texture, staining, topography, and lack of vegetative cover. Additional sampling locations may be identified during the RI field effort.

All surface soil samples will be analyzed for 13 target analyte list (TAL) metals including: antimony, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, and zinc. All samples will be sent to an offsite laboratory for total metals analysis (ICP-AES methods). A subset of samples (4 samples) will also be analyzed for particle size (texture), cation exchange capacity (CEC) and complete agricultural (includes pH; conductivity; nitrogen-phosphorus-potassium; organic matter; lime recommendation; and fertilizer recommendation). The 4 samples selected for the additional analysis will be selected based on the probability that the soil may be reclaimed in place and not have total metals concentrations above the PRG values.

Table 4-3 lists the approximate number of samples that will be collected to characterize the extent of soil contamination. The soil sampling locations will be identified during the initial phase of the RI. All surface soil samples will be collected from 0 to 3 inches below ground surface with a trowel.

TABLE 4-3

**PROPOSED SOIL, SEDIMENT, SURFACE WATER, AND GROUNDWATER SAMPLES
SPRING MEADOW LAKE SITE**

Sample Type	Analysis	Number of Samples	Number of Contingency Samples
Soil (0-3")	TAL Metals	10	2
	Particle size (texture)	4	2
	CEC	4	2
	Complete Agricultural (pH; conductivity; N-P-K; OM; lime and fertilizer requirement)	4	2
Subsurface Soil (24 backhoe pits, 2 samples collected in each pit)	TAL Metals	48	5
	Particle size (texture)	8	5
	CEC	8	5
	Partial Agricultural (pH; N-P-K; texture; and lime requirement)	8	5
Background Soil (0-3")	TAL Metals	3	1
	Particle size (texture)	2	1
	CEC	2	1
	Complete Agricultural (pH; conductivity; N-P-K; OM; lime and fertilizer requirement)	2	1
Sediment (0-1")	TAL Metals	8	1
	TOC	8	1
Surface Water	TAL Metals	3	1
	Field Parameters (pH, conductivity, hardness, chloride, sulfate)	3	1
Groundwater	TAL Metals	2	0
	Field Parameters (pH, conductivity, hardness, chloride, sulfate)	2	0

Notes:

TAL Target analyte list (antimony, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, and zinc)
 CEC Cation exchange capacity
 TOC Total organic carbon

Subsurface Soil

Subsurface soil samples will be collected to characterize the tailings and mineral processing wastes and to verify the depth of contamination and the thickness of the waste sources. Subsurface soil samples will be collected from 24 backhoe pits completed in and around the waste source areas at the Spring Meadow Lake site. Proposed backhoe pit locations are shown on Figure 4-1. Forty-eight soil samples will be collected from within and below the waste material in each backhoe pit and analyzed for total metals using an offsite laboratory. The locations of the backhoe pits have been preliminarily identified based on the results from the site inspection and hazardous materials inventory (DEQ-MWCB 2004) and to provide additional coverage for areas not yet characterized. The results from the subsurface soil sampling will increase the accuracy of the waste volume calculations.

Up to 8 samples will also be analyzed for particle size (texture), CEC, and partial agricultural parameters. The samples submitted for these additional analyses will be selected as typical of the wastes and of the buried soils below the wastes. The samples submitted for partial agricultural parameters will be collected from the soil immediately below the wastes to assess the potential for metals leaching from the wastes and to determine the recommended lime and fertilizer requirements for these buried soils. Samples from within 3 feet of the surface will be collected from the trench walls by using a trowel to fill the sample containers. Samples from depths greater than 3 feet below ground surface will be collected from the backhoe bucket by using a trowel to fill the sample container. The locations of the backhoe pits will be surveyed using a handheld global positioning survey (GPS) instrument.

All soil sampling equipment will be decontaminated using the procedures described in Section 4.2.9 before collecting the next sample.

Background Soil Samples

Three soil samples will be collected outside of the impacted area to establish background metals concentrations. All surface soil samples will be collected from 0 to 3 inches below ground surface using the same methods used to collect the other surface soil samples. The background sampling locations will be identified during the initial phase of the RI.

4.2.3 Sediment Sampling Procedures

The potential environmental/health risks and reclamation alternatives associated with sediment contamination in Spring Meadow Lake will be evaluated by collecting grab samples at various locations in the east arm and south end of Spring Meadow Lake. Eight sediment samples will be collected from the central areas of the east arm and from approximately 25 feet from the footbridge. Grab samples will be collected from a boat using a standard sediment sampling device (Ponar or coring tube). The sediment sampler will be lowered to the surface of the bottom sediments and opened up or rotated into the sediment. The sediment grab sampler is relatively easy to handle and operate, and generally provides high sample integrity. The sediment sampler can collect sediments to a depth of about 6 inches (15 centimeters) which should provide sufficient sample volume for analysis. All sediment samples will be decanted of excess water and sent to an offsite laboratory for total metals analysis. Sediment samples will also be analyzed for organic matter content to help evaluate the solubility and bio-availability of the metals. The proposed sediment sampling locations are shown on Figure 4-1.

4.2.4 Surface Water Sampling Procedures

The risk to potential receptors from surface water contamination will be evaluated during the RI. Twelve surface water samples were collected during the site inspection and hazardous wastes inventory (DEQ-MWCB 2004) and analyzed for total metals at an offsite laboratory. Three water samples (SW-109, SW-110, and SW-112) had arsenic concentrations above the human health surface water standard of 0.018 milligrams per liter (mg/L) (Montana DEQ 2004). In addition, two water samples (SW-110 and SW-112) had manganese concentrations above the Montana manganese standard of 0.050 mg/L (Montana DEQ 2004). In order to complete the ecological risk assessment during the RI, some additional water quality data (hardness, Cl, sulfate) are needed. Three additional surface water samples are proposed to be collected for the RI. The risk to potential receptors will be evaluated using the previous surface water data and the additional RI water quality data. The surface water samples will be analyzed for the parameters listed in Table 4-3. The proposed surface water sampling locations are shown on Figure 4-1.

Surface water samples will be collected from a boat by dipping the sample container into the lake water with the mouth pointed upward. After the container is full, the required preservative (if any) will be added to the bottle. The samples will not be filtered.

4.2.5 Groundwater Installation and Sampling Procedures

Two groundwater monitoring wells are proposed for installation and sampling at the Spring Meadow Lake site. The proposed monitoring wells will be constructed in accordance with State of Montana monitoring well standards. Proposed monitoring well locations are shown on Figure 4-1 but the final selection will be made in consultation with the Montana DEQ project manager and the Montana FWP personnel.

Monitoring Well Installation

Monitoring well installations will follow Tetra Tech EM Inc. Standard Operation Procedure (SOP) No. 020 (Attachment 1), with the top of casing flush mounted or with the casing stick-up, as appropriate. The monitoring wells will be constructed using two-inch ID Schedule 40 PVC riser with flush threaded joints and Schedule 40 PVC screen with 0.02-inch machined slots. The riser and screen lengths will be determined in the field based on total boring depth and depth to the water table. Material specifications and completion depths will be recorded during well construction and documented on a well completion log.

The monitoring well filter pack will consist of 10-20 mesh silica sand placed from the bottom of the borehole to two feet above the top of the screen. The annular seal placed above the filter pack will consist of approximately two feet of hydrated bentonite pellets. A grout mixture of 95 percent cement and five percent bentonite will be poured from the top of the annular seal to approximately two feet below the ground surface. Concrete will then be poured in the space above the grout to form a surface seal and set the protective casing. The concrete surface seal will be sloped to allow for drainage of surface water away from the well. The volume of material placed in the borehole to form the filter pack, annular seal, and surface seal will be calculated and recorded on the well completion log.

The monitoring well screen and riser material will be assembled and lowered by hand through the augers to the desired depth. The 10-20 mesh silica sand will be poured or tremied through the augers to form the filter pack. The auger will be removed from the borehole as the filter pack is poured. Bentonite pellets will then be poured or tremied through the augers to a minimum thickness of 2 feet and hydrated with potable water to form the annular seal. Grout will be poured or tremied through the augers on top of the bentonite seal to within approximately two feet below ground surface. Grout will be continuously added as the remaining auger is removed from the borehole.

Monitoring Well Development and Purging

Monitoring well development activities will be performed in accordance with Tetra Tech EM Inc. SOP No. 021 (Attachment 2). The monitoring well will be allowed to stabilize for a minimum of 24 hours after completion to allow for adequate curing of the grout. Prior to well development, the depth to water will be measured using a water level probe. These measurement will be used to determine the well casing volume and minimum purge volume. Before purging, the well will be surged by manually raising and lowering a surge block through the water column for a minimum of 10 minutes.

After the well has been surged, a portable pump will be used to evacuate a maximum of 10 casing volumes of water from the well. A new piece of disposable tubing will be attached to the pump and lowered to variable depths below the water table to evacuate the water from the well and introduce groundwater into the well from the aquifer. Water quality parameters including pH, specific conductance, and temperature will be measured upon the removal of each casing volume of water to provide baseline information. Prior to use, all water quality meters will be calibrated in accordance with the manufacturer's specifications. Monitoring well development will continue until two consecutive sets of water quality parameter measurements have stabilized to within 10 percent and the purge water is reasonably free of sediment, or until 10 casing volumes have been removed. Monitoring well development activities will be documented on a well development form.

Observations of water level, flow rate, and the quantity and clarity of the water withdrawn will be monitored during this process and recorded on water quality sheets during well development and while purging for sampling. During purging of the monitoring well using the submersible or peristaltic pump, field parameters will be measured using a closed flow-through cell system. Field parameters measured will include temperature, pH, conductivity, Eh, and turbidity. Parameters are considered stabilized when three or more sequential measurements are within ± 0.2 °C for temperature, ± 3 percent for conductivity, and ± 0.1 unit for pH (EPA 1996). Purging will continue until temperature, conductivity, pH, and water clarity have stabilized. A groundwater sample will then be collected. If the stabilization parameters do not fall within the specified ranges after three well volumes have been purged, then a comment will be recorded on the data sheet that sample collection began after three well casing volumes were purged. If the well runs dry before the specified amount of purge water has been withdrawn, the well will be allowed to recharge. After the well has recharged, one set of stabilization parameters will be measured and the well will be sampled.

Groundwater Sample Collection

The groundwater samples will be collected using the traditional bailing sampling method as described in Tetra Tech EM Inc. SOP No. 010 (Attachment 3). Disposable polypropylene bottom-weighted bailers will be used. Because volatile compounds and organic chemicals are not expected chemicals of concerns in groundwater at this site, some minimal aeration of the water column will not affect the quality of the water samples. Groundwater samples will be collected from monitoring wells following well development and purging. All groundwater samples will be filtered at the laboratory prior to analysis. The need for additional groundwater sampling will be evaluated and performed after the completion of this RI.

4.2.6 Field Analytical Procedures

Field analysis will be collected within Spring Meadow Lake and the east arm at the sediment and surface water sampling locations. Field measurements will be recorded at a water depth approximately half way between the lake surface and the bottom of the lake immediately prior to collecting the samples. The water quality parameters that will be measured in the field include pH, Eh, dissolved oxygen, specific conductance, and temperature. The pH, Eh, dissolved oxygen, specific conductance, and temperature will be measured with field portable meters. The instrument will be calibrated using the manufacturer's recommended procedures. The probes will be inserted into the water and the pH, Eh, dissolved oxygen, specific conductance, and temperature readings will be recorded. Before every sample, a check standard will be measured to verify instrument calibration. Before every second sample, a series of three measurements will be made to check instrument response and precision.

4.2.7 Sample Documentation and Custody

The possession and handling of each sample will be properly documented to promote timely, correct, and complete analysis for all required parameters. To promote sample integrity, each sample will be traceable from the point of collection through analysis and final disposition.

The field records and documentation control measures to be used during sample collection, identification, handling, and shipping include the following:

- Sample labels

- Custody seals
- Field sample data and chain-of-custody record

The Tetra Tech EM Inc. field team leader is responsible for obtaining these items and distributing them to field personnel. All paperwork will be completed using indelible ink.

Sample Designation

A sample numbering scheme has been developed that allows each sample to be uniquely identified and provides a means of tracking the sample from collection through analysis. The numbering scheme indicates the sample type, location, and depth (or interval depth). The unique sample number will be entered on sample labels, field tracking sheets, chain-of-custody forms, and other records documenting sampling activities. The following sample numbering system will be used for this investigation:

X-Y-Z

where:

- X = Sample Type (BG = background soil sample; BP = backhoe pit subsurface soil sample; MW = monitoring well; SD = sediment sample; SS = surface soil sample; and SW = surface water sample)
- Y = Sample Location (for example, test pit number)
- Z = Depth only for subsurface soil samples (test pit)

for example: BP-01-10 would be a subsurface soil sample from test pit 01 collected at a depth of approximately 10 feet below ground surface.

A matrix spike/matrix spike duplicate (MS/MSD) will also be submitted to the subcontractor laboratory for analysis for each sample matrix. Surface water MS/MSD samples require triplicate volumes for each analyte. The sample designation for the MS/MSD surface water samples is identical to the normal sample; however, one suite of the triplicate volume will be labeled MS and the other volume MSD. Soil samples selected for MS/MSD analysis will be designated in a similar manner.

Field Logbook

Daily field activities will be documented through journal entries in a bound field logbook, dedicated to the Spring Meadow Lake site. Logbook entry and custody procedures will follow National Enforcement

Investigation Center policies and procedures (EPA 1986). The logbook will be water-resistant, and all entries will be made in indelible ink. The logbook contains all pertinent information about sampling activities, site conditions, field methods used, general observations, and other pertinent technical information. Examples of typical logbook entries include the following:

- Personnel present
- Daily temperature and other climatic conditions
- Field measurements, activities, and observations
- Referenced sampling location description (in relation to a stationary landmark) and map
- Media sampled
- Sample collection methods and equipment
- Date and time of sample collection
- Types of sample containers used
- Sample identification and cross-referencing
- Sample types and preservatives used
- Analytical parameters
- Sampling personnel, distribution, and transporters
- Site sketches
- Instrument calibration procedures and frequency
- Visitors to the site

The Tetra Tech EM Inc. field team leader or designee will be responsible for the daily maintenance of all field records. Each page of the logbook will be numbered, dated, and signed by the person making the entry. Corrections to the logbook will be made by using a single strike mark through the entry to be corrected, then recording and initialing the correct entry. For corrections made at a later date, the date of the correction will be noted.

Color photographs taken during the sampling activities will be numbered to correspond to logbook entries. The name of the photographer, date, time, site location, and photograph description will be entered sequentially in the logbook as photographs are taken. Adequate logbook notations and receipts will be retained to account for custody during film processing.

Chain-Of-Custody Record

A chain-of-custody record establishes the documentation necessary to trace sample possession from time of collection through sample analysis and disposition. A sample is in the custody of a person if any of the following criteria are met:

- The sample is in a person's physical possession.
- The sample is in a person's view after being in his or her physical possession.
- The sample was in a person's physical possession and was then locked up or sealed to prevent tampering.
- The sample is kept in a secured area.

The sample collector will complete a chain-of-custody record to accompany each sample delivery container (cooler) and will be responsible for shipping samples to the laboratory. The sample collector will provide the project number and the sample collector's signature as header information on the chain-of-custody record. For each station number, the sample collector will indicate the date, time, station location, number of containers, analytical parameters, and designated sample numbers. When shipping the samples, the sample collector will sign the bottom of the form and enter the date and time (military) that the samples were relinquished. The sample collector will enter the carrier name and air bill number on the form. The original signature copy of the chain-of-custody record will be enclosed in a plastic bag and secured to the inside of the cooler lid. A copy of the chain-of-custody record will be retained for Tetra Tech EM Inc. files.

Each shipping cooler will be secured for shipment by placing custody seals across two sides of the cooler lid. Commercial carriers are not required to sign the chain-of-custody form, provided that the form is sealed inside the shipping cooler and the custody seals remain intact. The subcontractor laboratories will carry out the chemical analyses and are responsible for storing the samples in a secure location and following all chain-of-custody procedures.

Sample Shipment

All samples will be packaged and labeled for shipment in compliance with current regulations. Only metal or plastic ice chests will be used for shipping samples. The samples will be placed in the cooler and padded with bubble wrap to absorb shock. The chain-of-custody form will then be placed in a sealed plastic bag and taped to the inside of the cooler lid. The ice chest will be securely taped shut and the custody seals and shipping airbill will be attached.

4.2.8 Sample Preservation and Handling

The preservation and holding time requirements for the samples and analysis described in Sections 4.2.1 through 4.2.5 are listed in Table 4-4.

TABLE 4-4
SAMPLE COLLECTION, PRESERVATION, AND HOLDING TIME REQUIREMENTS
SPRING MEADOW LAKE SITE

Matrix	Analyte	Preservation	Holding Time	Sample Size	Bottle
Soil	EPA 6010 TAL Metals	Cool to 4°C	180 days; Hg 28 days	8 ounce	8-ounce polyethylene
Water	EPA 6010 TAL Metals	Cool to 4°C, HNO ₃ to pH < 2	180 days; Hg 28 days	1 liter	1-liter polyethylene
Soil	Particle Size	None	None	4 ounce	4-ounce polyethylene
Soil	Cation Exchange Capacity	None	None	4 ounce	4-ounce polyethylene
Water	Total Dissolved Solids ^b	Cool to 4°C	7 days	1 liter	1-liter polyethylene
Water	Hardness ^b		28 days		
Water	Alkalinity/Acidity ^b		7 days		
Water	Sulfate ^b		28 days		
Water	Chloride ^b		28 days		
Water	Nitrate/Nitrite	Cool to 4°C H ₂ SO ₄ to pH < 2	28 days	250 milliliter	250-milliliter polyethylene

Notes:

^a Analytes can be analyzed from the same 1-liter sample bottle

TAL Target analyte list (antimony, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, and zinc)
HNO₃ Nitric acid
H₂SO₄ Sulfuric acid
EPA Environmental Protection Agency °C Degree Celsius

4.2.9 Decontamination Procedures

Decontamination will be required for all sampling equipment, personal protective gear, and field monitoring equipment used during field activities. Sampling equipment will be decontaminated between collection of each sample. Liquinox or Alconox cleaning solutions and distilled water rinses will be used for all sampling equipment and tools. Decontamination procedures for specific equipment used in association with field activities are described in the following sections.

Excavation Equipment

All excavation equipment will be decontaminated at designated locations within the Spring Meadow Lake site. The decontamination locations will be identified before fieldwork begins. Decontamination will be performed before excavation operations begin and between excavation pit locations. Decontamination will consist of examining the backhoe bucket and removing residual soil.

Sampling Equipment

All non-disposable sampling equipment will be decontaminated before and after use. Sampling equipment may include shovels, sediment sampler, and hand trowels. Laboratory-supplied sample containers are provided precleaned and will not require decontamination.

In general, the following procedures will be used for sampling equipment decontamination:

- Scrub the sampling equipment in a bucket using a stiff brush and Liquinox or Alconox solution with potable water.
- Triple-rinse the sampling equipment with potable water.
- Final rinse the sampling equipment with distilled water and allow to air dry in a clean dust-controlled area.
- Store the equipment in clean plastic bags until the next sampling event.

4.3 QUALITY ASSURANCE PROTOCOL PLAN

This QAPP has been prepared to support the reclamation work plan and field sampling plan and describes the quality assurance (QA) for the RI of the Spring Meadow Lake site. This QAPP presents the data quality objectives; QA objectives; QA sample collection procedures; sample documentation and custody;

equipment operation, maintenance, and calibration; analytical procedures; data reduction, validation, and reporting; and corrective action procedures.

4.3.1 Data Quality

Data quality objectives (DQO) are qualitative and quantitative statements that specify the quality of the data required to support the RI activities. The data quality objectives for the project and the type, analytical level, and use of the data are presented below.

Data Quality Objectives

DQOs were prepared using EPA guidance for the data quality objectives process (EPA 1994). The EPA guidance (1994) presents the DQOs as a seven-step process:

Step 1 - State the Problem. Concisely describe the problem to be studied.

Step 2 - Identify the Decision. Identify what questions the study will attempt to resolve and what actions may result.

Step 3 - Identify the Inputs to the Decision. Identify the information that needs to be obtained and the measurements that need to be taken to resolve the decision statement.

Step 4 - Define the Study Boundaries. Specify the time periods and spatial area to which the decisions will apply.

Step 5 - Develop a Decision Rule. Define the statistical parameter of interest, specify the action level, and integrate the previous DQO outputs into a single statement that describes the logical basis for choosing among alternative actions.

Step 6 - Specify Tolerable Limits on Decision Errors. Define the decision maker's tolerable decision error rates based on a consideration of the consequences of making an incorrect decision.

Step 7 - Optimize the Design. Evaluate information from the previous steps and generate alternative data collection designs.

The following paragraphs describe each step, as listed above, and how it pertains to the investigation of the Spring Meadow Lake site.

Step 1: Stating the Problem

The Spring Meadow Lake site is a State park and Montana Wildlife Center located in Helena, Montana. Tailings and mineral processing wastes have been disposed of at this site and contain elevated concentrations of arsenic, manganese, lead, and zinc. Preliminary evaluation of site risks using the abandoned inactive mine scoring system (AIMSS) suggests that the tailings and mineral processing wastes may pose an unacceptable risk to ecological receptors and human recreational users. The objective for the project is to protect human health and the environment in accordance with the guidelines set forth by the NCP.

Step 2: Identify the Decision

Previous data and inspection of the site reveal that mineral process tailings with levels of arsenic and lead are found at a depth greater than eighteen feet below ground surface. In addition, mineral processing wastes containing elevated levels of manganese are found on the surface of the site and in shallow sediments of the east arm of Spring Meadow Lake. These materials may cause adverse impacts to human health and the environment. The following decisions will be made: What reclamation action is necessary at the site to protect human health and the environment? What is the areal extent and volume of tailings, mineral processing wastes, and metal contaminated soil and sediment? How will the characteristics of the mineral processing wastes and underlying soil impact revegetation of the site? How will the physiography of the site affect reclamation alternatives? Are there suitable repository sites and soil borrow areas near the site?

Step 3: Identify the Inputs to the Decision

The areal extent of tailings, mineral processing wastes, and metal contaminated soil and sediments, and the characteristics of soil underlying the wastes will be determined by analyzing soil, sediment, surface water, and groundwater samples for metals and reclamation parameters. The volume of wastes and the physiography of the site will be determined by completing a survey of site topography and site features. Potential repository sites and soil borrow areas will be identified and the site characteristics will be determined through the excavation of test pits and the collection of soil samples for agronomic analyses.

Step 4: Define the Study Boundaries

The disturbed area at the Spring Meadow Lake site covers approximately 2 acres in the NE1/4 of the SW1/4 of Section 23, Township 10 North, Range 4 West, in Lewis and Clark County, Montana.

Step 5: Develop a Decision Rule

The potential receptors at the site include recreational users, terrestrial wildlife, vegetation, and aquatic life. Reclamation of the site will be necessary if levels of contaminants in surface and subsurface soil samples exceed the recreational cleanup levels and pose unacceptable risks to human health and the environment. Reclamation may include, but is not limited to, mine waste removal and reclamation-in-place actions.

Step 6: Specify Tolerable Limits on Decision Errors

In general, environmental data may be strongly indicative of site conditions, but data are not absolutely definitive; therefore, decisions based upon the data could be in error. This is known as the decision error. This section discusses the limits on decision errors for this investigation.

Sampling error and measurement error are associated with environmental data collection and may lead to decision error. Sampling error occurs because it is impossible for a sampling effort to measure conditions at every point of a site or at every point in time. Sampling error occurs when the sample is not representative of the true state of the environment at a site. Measurement error occurs because of random and systematic errors associated with sample collection, handling, preparation, analysis, data reduction, and data handling. The two types of errors may lead to incorrect decisions or recommendations. In general, decision errors are controlled by adopting a scientific approach that uses hypothesis testing to minimize the potential for decision errors. EPA guidance (1994) suggests the following steps to identify and control decision errors:

- Define the possible range of the parameter of interest,
- Define both types of decision errors and the consequences of each, and
- Specify a range of parameter values for which the consequences of decision errors are relatively minor.

Decision errors are evaluated through hypothesis testing. The reclamation may result in members of the public coming into contact with site wastes. Therefore, the null hypothesis for recreational use is that the site waste contains concentrations of contaminants above the risk-based recreation cleanup levels. The site may also have terrestrial wildlife, vegetation, and aquatic life that are exposed to site wastes and contaminated sediments and surface water runoff. Therefore, the null hypothesis for vegetation, terrestrial wildlife, and aquatic receptors is that site wastes materials, sediments, and surface water runoff are contaminated.

There are two types of decision errors:

False Negative Error. A false negative decision error occurs when the hypothesis is rejected although it is true. In the case of this project, the decision-maker would determine that the site does not contain mineral processing wastes, soil, surface water, sediment, or groundwater that require additional reclamation although concentration levels do require additional reclamation. The consequences of a false negative error would be that contaminated soil and groundwater are left in place instead of being reclaimed.

False Positive Error. A false positive decision error occurs when the hypothesis is not rejected although it is false. In the case of this project, the decision-maker would determine that the site contains mineral processing wastes, soil, surface water, sediment, and groundwater that require reclamation (based on the results of the analytical data), although the concentrations of contaminants in the wastes, soil, surface water, sediment, or groundwater do not require reclamation. The consequences of a false positive error would be that unnecessary resources may be spent to perform additional reclamation to address contamination that does not exist at levels exceeding action levels or acceptable risk levels.

Limits on decision errors due to sampling error will be minimized by using the analytical results from the site inspection and hazardous materials inventory (DEQ-MWCB 2004), other previously collected and reported data from the site (Montana DEQ, Carroll College, Montana FWP) and visual observations to identify contaminated areas. The sampling approach will be to collect enough data to define the areal and vertical extent of contamination.

Step 7: Optimize the Design

The collection of surface soil and subsurface soil samples should be adequate to accept or reject the null hypothesis for recreational exposure. Visual examination of the site together with incorporation of previous site analytical data will be used to bias the collection of samples. The analytical results will be used to locate and characterize the extent of contamination, risk assessment, and reclamation design.

The collection of surface water and sediment samples should be sufficient to accept or reject the null hypothesis for exposure of aquatic organisms. Representative areas within the south end and east arm of Spring Meadow Lake will be sampled to characterize potential impacts.

Data Type, Analytical Level, and Use

Table 4-5 presents data quality objectives, including data analysis or measurement, location of that measurement, analytical method, analytical support level, sample media, and the data use.

The analytical support levels are the analytical options available to support data collection activities. There are five general levels that are distinguished by the types of technology, documentation use, and degree of sophistication, which are:

- Level V - Nonstandard methods. Analyses that may require method modification and development. Analyses performed by the EPA Contract Laboratory Program (CLP) under a Special Analytical Service (SAS) request are considered Level V.
- Level IV - EPA CLP Routine Analytical Service (RAS). This level is characterized by rigorous QA protocols and documentation and provides qualitative and quantitative analytical data. Some commercial laboratories provide this level of data.
- Level III - Laboratory analysis using methods other than EPA CLP RAS methods. This level is used primarily in support of engineering studies using standard EPA-approved procedures. Some procedures may be equivalent to CLP RAS without the CLP requirements for documentation.
- Level II - Field analysis. This level is characterized by the use of portable analytical instruments on site or in mobile laboratories stationed near the site.
- Level I - Field screening. This level is characterized by the use of portable instruments that can provide real-time data to assist in optimizing sampling point locations and for health and safety support.

Analytical levels to be implemented during the Spring Meadow Lake site activities are Levels II, III, and IV.

TABLE 4-5
SUMMARY OF DATA QUALITY OBJECTIVES
SPRING MEADOW LAKE SITE

Analysis	Location	Analysis Method	Analytical Support Level	Media	Data Use
TAL Metals	Laboratory	EPA 6010b	IV	SS, SW, GW	SC, RA, RA, ED
Particle Size	Laboratory	Method D421 ASTM	III	SS	SC
Cation Exchange Capacity	Laboratory	Method 9080 SW-846	III	SS	SC
Complete and Partial Agricultural Analysis	Laboratory	MSA, Second Edition	III	SS	SC
Total Dissolved Solids	Laboratory	Method 160.1 (EPA 1999)	III	SW, GW	SC, RA, EA, ED
Hardness	Laboratory	SM 2340B	III	SW, GW	SC, RA, EA, ED
Alkalinity	Laboratory	EPA 310.1	III	SW, GW	SC
Sulfate	Laboratory	Method 9038 SW-846	III	SW, GW	SC, RA, EA, ED
Acidity	Laboratory	EPA 305.1	III	SW, GW	SC
Chloride	Laboratory	Method 325.3 (EPA 1999)	III	SW, GW	SC, RA, EA, ED
Specific Conductivity, Temperature	Field	Manufacturer's Instructions	II	SW, GW	SC
pH, Eh, Dissolved Oxygen	Field	Manufacturer's Instructions	II	SW, GW	SC

Notes:

ASTM	American Society of Testing and Materials (ASTM 1985)
EA	Evaluation of alternatives
ED	Engineering design
EPA	Environmental Protection Agency
EPA 1999	Methods and Guidance for the Analysis of Water, Version 2
GW	Groundwater
MSA	Methods of Soil Analysis Part 3: Chemical Methods (ASA 1996)
RA	Risk assessment
SC	Site characterization
SM	Standard Method
SS	Soil or sediment
SW	Surface water
SW-846	Test Methods for Evaluating Solid Waste - Physical Chemical Methods, SW-846 (EPA 1996)
TAL	Target analyte list includes: antimony, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, and zinc

4.3.2 Quality Assurance Objectives

The overall QA objective for the Spring Meadow Lake site RI is to produce well-documented data of known quality. Meeting this objective involves establishing and meeting goals for precision, accuracy, completeness, representativeness, comparability, and target reporting limits for the analytical methods. The quantitative and qualitative QA objectives are presented below.

If analytical data fail to meet the QA objectives described in this section, Tetra Tech EM Inc. will explain in the RI report why the data failed to meet the objectives (for example, because of matrix interferences), and will describe the limitations and usability of the data. The following corrective actions may be taken for data that do not meet QA objectives: (1) verify that the analytical measurement system was in control, (2) thoroughly check all calculations, (3) use data qualifiers, and (4) assuming a sufficient quantity of sample is available, reanalyze the affected samples, if authorized by the Montana DEQ Spring Meadow Lake site project manager. Corrective actions for internal QA and quality control (QC) are presented in detail in Section 4.3.7.

The data precision, accuracy, and completeness requirements are listed in Table 4-6; Table 4-7 lists the target reporting limits (TRL) for all analytes of concern by each analytical method. Table 4-5 presents the specific analytical methods selected for determining the concentration of components in the identified matrices.

Quantitative QA Objectives

Quantitative QA objectives that will be evaluated for both the field and laboratory data include completeness, accuracy, precision, and method detection limits. The following sections discuss the calculation of each QA objective.

Precision and Accuracy

Precision and accuracy are indicators of data quality. Generally, precision is a measure of the variability of a group of measurements compared to their mean value. Laboratory analytical precision is estimated by calculating the relative percent difference (RPD) between the analytical results from the matrix spike (MS) and matrix spike duplicate (MSD) samples for low-level samples and laboratory duplicate samples for high-level samples.

TABLE 4-6

**PRECISION, ACCURACY, AND COMPLETENESS REQUIREMENTS
SPRING MEADOW LAKE SITE**

Analyte	Matrix	Precision	Accuracy	Completeness
Metals	Soil Sediment	± 35% RPD between homogenized sample aliquots	Calibration, LCS to CLP data validation functional guideline criteria Matrix Spike Recovery 75% to 125%	90%
	Water	± 20% RPD between duplicate samples	Calibration, LCS to CLP data validation functional guideline criteria Matrix Spike Recovery 75% to 125%	90%
Particle Size	Soil	± 35% RPD between homogenized sample aliquots	Method-specified calibration	90%
Cation Exchange Capacity	Soil	± 35% RPD between homogenized sample aliquots	Method-specified calibration	90%
Total Dissolved Solids	Water	± 20% RPD between duplicate samples	Method-specified calibration	90%
Hardness	Water	± 20% RPD between duplicate samples	Method-specified calibration	90%
Sulfate	Water	± 20% RPD between duplicate samples	Method-specified calibration	90%
Alkalinity Acidity	Water	± 20% RPD between duplicate samples	Method-specified calibration	90%
Chloride	Water	± 20% RPD between duplicate samples	Method-specified calibration	90%
Field Parameters	Water	± 10% RPD between replicate measurements	Method-specified calibration	90%

Notes:

RPD	Relative percent difference	LCS	Laboratory check sample	Percent
	less than	CLP	Contract Laboratory Program	MS
MSD	Matrix spike duplicate			Matrix spike

TABLE 4-7

**TARGET REPORTING LIMITS FOR SOIL, SEDIMENT,
AND WATER METAL ANALYSIS
SPRING MEADOW LAKE SITE**

Analyte Type	Method	Analyte	Reporting Limit Soil and Sediment (mg/kg)	Reporting Limit Water (µg/L)
TAL Metals	SW-846 6010B, 6020, and 7471	Antimony	5	50
		Arsenic	5	5
		Barium	5	100
		Cadmium	1	1
		Chromium	5	10
		Copper	5	10
		Iron	5	30
		Lead	5	10
		Manganese	5	10
		Mercury	1	1
		Nickel	5	10
		Silver	5	5
		Zinc	5	10

Notes:

µg/L

Micrograms per liter

mg/kg

Milligrams per kilogram

TAL

Target analyte list (antimony, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, and zinc)

SW-846

Test Methods for Evaluating Solid Waste - Physical/Chemical Methods, SW-846 (EPA 1996)

The RPD between the analyte levels measured in the MS sample and MSD sample (or sample duplicates) will be calculated using the following equation.

$$RPD = \frac{|MS - MSD|}{0.5 (MS + MSD)} \times 100\%$$

Where:

RPD = Relative percent difference
 MS = Matrix spike
 MSD = Matrix spike duplicate

Accuracy is a measure of the bias in a measurement system. Sampling accuracy is assessed by analyzing field and equipment blanks. The blanks are used to determine if the ambient air, sample containers, or sample preservatives are contaminating the sample. Analytical accuracy for laboratory data is assessed by evaluating matrix spike sample percent recovery, instrument calibration data, and laboratory control sample results.

Accuracy will be estimated by calculating the percent recovery of laboratory MS samples using the following equation.

$$\%R = \frac{(C_j - C_o)}{C_t} \times 100\%$$

Where:

%R = Percent recovery
 C_j = Measured concentration in spiked sample aliquot
 C_o = Measured concentration in unspiked sample aliquot
 C_t = Actual concentration of spike added

Precision and accuracy goals depend on the types of samples and analysis to be performed and the ultimate use of the analytical data.

Completeness

Completeness is defined as an assessment of the amount of valid analytical data obtained from a measurement system compared to the amount of analytical data needed to achieve a particular statistical level of confidence. The percent completeness is calculated by dividing the number of samples with

acceptable data by the total number of samples planned to be collected, and multiplying the result by 100. For this project, the QA objective for degree of completeness for the laboratory is 90 percent. If completeness is less than 90 percent, Tetra Tech EM Inc. will provide documentation explaining why this objective was not met, and the impact, if any, of a lower percentage on the project. Completeness will be reported as the percentage of all measurements judged valid. The following equation will be used to determine completeness:

$$\%C = (V/T) \times 100\%$$

Where:

%C	=	Percent completeness
V	=	Number of measurements judged valid
T	=	Total number of measurements

The completeness target for this project is 90 percent.

Target Reporting Limits

The analytical measurements are listed in Table 4-5. The target reporting limits (TRL) for soil and water metals analyses are listed in Table 4-7. The target reporting limit is defined as the lowest concentration that needs to be reported for undiluted samples to obtain project objectives. The laboratory will try to achieve the lowest reporting limits possible for all measurements and will notify the Tetra Tech EM Inc. project manager if the detection limits for the samples exceed the TRLs. If samples are diluted to qualify constituents present at high concentration levels or to reduce matrix interferences, the reporting limit will be calculated as the reporting limit for the particular matrix multiplied by the dilution factor. The actual matrix reporting limits for each sample will vary depending on the concentration of analytes present and the presence of any interference.

Qualitative QA Objectives

Qualitative QA objectives that will be evaluated include sample representativeness and comparability. The following sections present an analysis of the representativeness and comparability for each matrix to be sampled.

Representativeness

Representativeness is the degree to which sample data represent characteristics of a population, variation at a sample point, or an environmental condition. Sampling locations will be selected to obtain representative soil and groundwater samples. Representative data will also be obtained through the proper collection and handling of samples. The QA objective is to obtain a statistically adequate number of samples that represent the various process matrices at the time samples are collected. The FSP contains a discussion of the representativeness of samples from each environmental matrix.

Comparability

Comparability expresses the confidence with which one data set can be compared to another. Comparability will be maximized by using standard EPA methods and standard sampling techniques. Tetra Tech EM Inc. will document all sample locations, conditions, and field sampling methods. All results will be reported in standard units or, for field parameters, as defined in the method. All laboratory calibrations will be performed with standards traceable to the National Institute for Standards and Technology or to EPA-approved sources.

4.3.3 QA Sample Collection Procedures

Various types of QA/QC samples will be collected during the field investigation activities: MS, MSD, and laboratory sample duplicates.

MS, MSD, and Duplicate Samples

The RI field team will collect MS, MSD, and duplicate samples at a rate of 1 for every 20 samples collected. If fewer than 20 samples are collected in one day, then a minimum of one set of field duplicate samples will be collected. For water samples requiring MS/MSD analyses, three times the amount of sample required for routine analysis will be collected. Soil samples do not require the collection of additional sample volume. In the laboratory, two (for MS/MSD) aliquots of this sample will be spiked to allow determination of percent recoveries and RPD for the MS compounds. MS/MSD samples will be collected for each matrix and each analytical method at a rate of 1 per 20 samples.

4.3.4 Sample Documentation and Custody

The possession and handling of each sample will be properly documented to promote timely, correct, and complete analysis for all required parameters. To promote sample integrity, each sample will be traceable from the point of collection through analysis and final disposition. Sample documentation and custody procedures are presented in Section 4.2.7.

4.3.5 Equipment Operation, Maintenance, Calibration, and Standardization

The procedures and frequency for field instrument operation, initial and continuing calibration verification, and maintenance requirements are described in the analytical methods or instrument manufacturer's calibration procedures. Calibration data will be recorded in the field logbook as will the source and method of preparation of the standard solutions used. Tetra Tech EM Inc. will calibrate all field analytical equipment before it is shipped to the field, and daily, before and after use. All calibration standards will be prepared from commercially available (Supelco or equivalent) NIST, EPA-traceable, or EPA-certified standards. The laboratory instrument operation, calibration, and maintenance procedures are described in the analytical method.

4.3.6 Analytical Procedures

The field and laboratory analytical methods that will be used are listed in Table 4-5. Laboratory analysis of samples collected during the RI will be completed by laboratories that have established QA protocols that meet or exceed EPA guidelines. EPA methods will be used whenever they are available for the target analyte.

4.3.7 Data Reduction, Validation, and Reporting

Procedures must be used to ensure that all laboratory data generated and processed are scientifically valid, defensible, and comparable. The following sections describe the data reduction, validation, and reporting procedures that will be used in this RI.

Data Reduction

The results will be reported in milligrams per kilogram (mg/kg) for soil and sediment analysis and micrograms per liter (µg/L) for water analysis or using the procedures described in the analytical methods. In accordance with standard document control procedures, the laboratories will maintain on file the original copies of all data sheets and logbooks containing raw data, signed and dated by the responsible analyst. Separate instrument logs will also be maintained by the laboratories to enable a reconstruction of the run sequences for individual instruments. The laboratories will maintain all data on file in a secure archive warehouse accessible only to designated laboratory personnel. After three years, the laboratories will send all data on file to the Montana DEQ. The data will be disposed of only upon receipt of instructions to do so from Montana DEQ.

The laboratories will store all residual samples until disposal is authorized by the Montana DEQ. The laboratories will be notified within six months from the time of analysis of the disposition of residual samples. For the first 60 days after the laboratory receives the samples, samples and sample extracts will be stored in a refrigerator at 4°C. After that time, they may be stored at room temperature.

Data Validation

Individual analysts will verify that the appropriate data forms have been completed and the completeness and correctness of data acquisition and reduction. The laboratory group leader will review calculations daily and inspect laboratory notebooks and data sheets weekly to verify accuracy, completeness, and adherence to the specified analytical method protocols. Calibration and QC data will be examined daily by the individual analysts and the laboratory supervisor. The group leader and QA manager or designee will verify that all instrument systems are in control and that QA objectives for precision, accuracy, completeness, and TRLs are being met.

Analytical outlier data are defined as QC data lying outside a specific QA objective range for precision or accuracy for a given analytical method. If QC data are outside control limits, corrective action procedures will be applied to determine the probable causes of the problem. If necessary, the sample will be reanalyzed, and only the reanalyzed results reported. If the problem is with the matrix, both initial and reanalyzed results will be reported and identified in the laboratory report. If reanalysis is not feasible, the initial analysis results will be reported and the results will be flagged and identified in the laboratory report.

Project outlier data are defined as sample data that are outside specified acceptance limits established around the central tendency estimator (the arithmetic mean) of the entire data set for the project. For data that are known or assumed to be normally distributed, the specified acceptance limits will be the 90 percent confidence limits defined by the Student one-tailed t-test distribution. Tetra Tech EM Inc. will identify project outlier data, which will be reported in the final laboratory report.

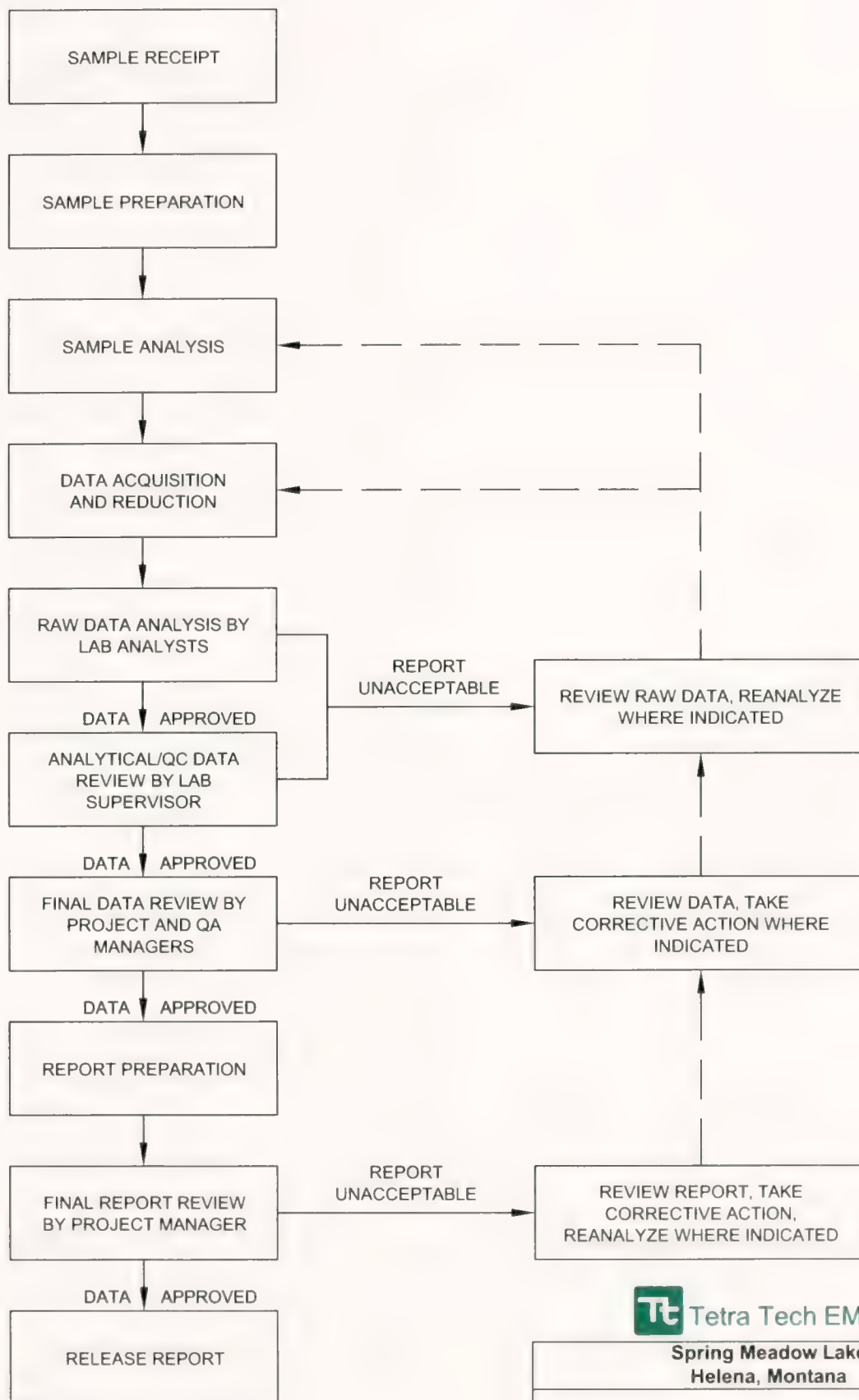
The laboratory project manager and QA coordinator will be responsible for laboratory data validation. The Tetra Tech EM Inc. project manager and Tetra Tech EM Inc. QA manager will be responsible for post-laboratory data validation of all data generated by the selected laboratories. The soil, sediment, and water metal data will be validated using the procedures described in Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analysis (EPA 1988).

Reporting

A flow chart depicting the overall data handling and reporting scheme is given in Figure 4-2. Data will be reported in standard units as described in the analytical methods.

The laboratory project manager will be responsible for reviewing the laboratory report. The completed laboratory report will be approved by the laboratory project manager. The laboratory will provide all raw data necessary to fully validate the data. Each data package will include the following items:

- Case narrative including a statement of samples received, description of any deviation from standard procedures, explanation of any data qualifiers used, and any problems encountered during analysis
- A QC summary report including applicable surrogate recoveries, MS MSD, recoveries, method blank results, and laboratory control sample recoveries. This report must identify all QC outliers and describe their impact on data quality and useability
- Chain-of-custody records
- Reporting limits
- Analytical instrument run logs
- Analytical instrument raw data for samples, blanks, and standards
- Initial calibration information
- Continuing calibration information
- Laboratory accuracy and precision limits
- All values below reporting limits and above method detection limits
- Date of analysis



Tetra Tech EM Inc.

Spring Meadow Lake
Helena, Montana

**FIGURE 4-2
DATA REDUCTION, VALIDATION,
AND REPORTING SCHEME**

The final report will contain a QA/QC summary that discusses whether the final data meet the original project QA objectives. If the QA objectives are not met, the report will contain an explanation of the impact on the evaluation of the project objectives.

4.3.8 Corrective Action Procedures

Corrective actions will be taken when any problems are identified in the program that affects product quality. The laboratory project manager and the Tetra Tech EM Inc. project manager, or their designees, are responsible for identifying the causes of the problems and developing a solution.

The cause of the problem must first be determined so that the effect of the problem on the overall program can be identified. The field team (and if necessary, the Montana DEQ project manager) will then develop a plausible corrective action. The effects of the action will be examined to determine whether the problem is addressed.

If the corrective action is initially successful, the laboratory project manager, or designee, will prepare a corrective action memorandum describing the corrective action, how and when it will be implemented, and the expected results. A copy of the memorandum will be sent to the Tetra Tech EM Inc. project manager and QA manager and then to the Montana DEQ project manager. The laboratory project manager, or designee, will be responsible for implementing the corrective action and assessing its effectiveness. Procedures are presented below for correcting (1) problems detected during audits, (2) laboratory problems, and (3) data outside control limits.

Performance and System Audits

The Tetra Tech EM Inc. program manager and QA manager will perform an internal QA audit of field procedures. If problems are detected during any field audit, the following procedures will be followed:

- The field team leader will immediately notify the field or laboratory personnel responsible, the Tetra Tech EM Inc. project manager, the Tetra Tech EM Inc. QA manager, and all other appropriate personnel of the problem and any corrective action to be taken.
- Personnel will then correct the problem according to the procedures outlined above.

Laboratory Corrective Actions

The laboratory QA manager will review laboratory procedures to identify conditions or procedures that may have an adverse impact on data quality. The QA manager will then assess the impact on the quality of the associated data, and then identify the corrective actions to be implemented. All conditions or procedures that may have an adverse impact on data quality will be included in the laboratory reports.

Data Outside Control Limits

The manner in which data outside of control limits are handled will depend on where the nonconformance is discovered. During data review in the laboratory, if QC checks fail to meet acceptance criteria, either the data will be flagged in accordance with standard EPA-defined data flags, or the nonconformance will be discussed in the case narrative. During the post-laboratory data validation, the data will be reviewed and assigned to one of the following three categories:

1. **Valid-unqualified** - This category is used for all data that meet all QC criteria without any qualifier. These data are useful for any purpose, and are not flagged.
2. **Valid-qualified** - Data placed in this category are valid, but their usefulness may be limited in certain situations. These data may be qualified as "estimated," which is indicated by use of a "J" flag, or by the use of a specific flag that conveys information about the limitations of the data.
3. **Invalid or Rejected** - Data are considered to be invalid in cases such as failure to properly ice samples that require storage at 4°C during shipment. These data are flagged with an "R" and are considered to be unusable for any purpose.

Data will be validated using EPA guidance documents and the specific requirements of this QAPP. If certain data appear to be borderline between two categories, the data validator may seek the advice of the individuals cited in Section 1.3.1 as having a QA function.

4.4 LABORATORY ANALYTICAL PLAN

This LAP describes laboratory requirements for conducting the RI at the Spring Meadow Lake site. Analysis of the solid matrix samples (surface soils, subsurface soils, and sediments), surface water, and groundwater samples will be conducted during the RI. All analytical work is to follow the requirements listed in this LAP for the duration of the project. This LAP contains four sections including sample collection requirements, laboratory requirements, quality assurance requirements, and analytical methods.

4.4.1 Sample Collection Requirements

Samples will be collected from surface soils, subsurface soils, sediments, surface water, and groundwater at the Spring Meadow Lake site. The number and type of samples are specified in Table 4-3 (Section 4.2.1).

The matrix, analyte, required preservation, holding time, sample size, and containers to be used during the Spring Meadow Lake site RI are specified in Table 4-5 (Section 4.2.8 of the FSP). Whenever possible, standard EPA protocols will be used.

4.4.2 Laboratory Requirements

The primary laboratory will be subcontracted by Montana DEQ for all total metals, particle size (texture), CEC, and agricultural analyses. The primary laboratory may use a separate laboratory for certain physical and chemical analyses. All laboratories for the project will be supplied with this document and will be required to meet the baseline data quality requirements for the project. All analyses performed by the project laboratories should follow the analytical methods listed in Table 4-8, which includes the applicable reference for each method.

TABLE 4-8

**SUMMARY OF ANALYSES AND ANALYTICAL METHODS
SPRING MEADOW LAKE SITE**

Analysis	Analytical Method	Media
TAL Metals	EPA 6010b	SS, SW, GW
Particle Size	Method D421 ASTM	SS
Cation Exchange Capacity	Method 9080 SW-846	SS
Complete and Partial Agricultural Analysis	MSA, Second Edition	SS
Total Dissolved Solids	Method 160.1 (EPA 1999)	SW, GW
Hardness	SM 2340B	SW, GW
Alkalinity/Acidity	EPA 310.1 305.1	SW, GW
Sulfate	Method 9038 SW-846	SW, GW
Chloride	Method 325.3 (EPA 1999)	SW, GW
Specific Conductivity, Temperature	Manufacturer's Instructions	SW, GW
pH, Eh, Dissolved Oxygen	Manufacturer's Instructions	SW, GW

Notes:

SS	Soil or sediment
SW	Surface water
GW	Groundwater
TAL	Target analyte list includes: antimony, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, and zinc
EPA 1999	Methods and Guidance for the Analysis of Water, Version 2 (includes EPA Series 500, 600, 1600 Methods) (EPA 1999)
SM	Standard Method
SW-846	Test Methods for Evaluating Solid Waste-Physical/Chemical Methods, SW-846 (EPA 1996)
MSA	Methods of Soil Analysis Part 3: Chemical Methods (ASA 1996)
CLP	Contract Laboratory Procedures
SOW	Statement of Work
EPA	Environmental Protection Agency
ASTM	American Society of Testing and Materials (ASTM 1985)

Qualifications and Experience

The laboratory shall designate and use key personnel meeting the minimum requirements, as specified below, and comply with all terms and conditions of the contract. Experience is defined as more than 50 percent of the person's productive work time in active participation on a given task and includes the following:

1. The Inductively Coupled Plasma (ICP) emission spectroscopist responsible for work under this contract must have at least one year of experience in the operation of the ICP on soil and water samples.

2. The Furnace Atomic Absorption (AA) spectroscopist responsible for the work on this contract must have at least one year of experience in the operation of a furnace AA on soil and water.
3. The Hydride Generation AA and Cold Vapor AA (CVAA) spectroscopist responsible for work on this contract must have specific training in hydride applications and at least one year of experience in the operation of hydride AA and CVAA.
4. The inorganic sample preparation expert performing sample preparation for this contract must have at least three months of experience in the preparation of environmental samples for ICP and AA analysis.
5. The analyst or technician responsible for determining soil pH on the contract must have at least six months of experience in the technique and instrumentation.
6. The sample custodian, who is responsible for receiving, logging, and tracking the samples for the laboratory must have at least three months experience. This requirement is necessary because of the large number of samples and complexity of the project.

The laboratory shall have in place an acceptable QA plan. The plan shall designate key QA individuals by name and shall define their responsibilities. The plan shall detail the mechanisms for checking whether laboratory procedures are within control, and shall detail the corrective actions and responsibilities for out-of-control conditions.

Subcontracting

Subcontracting portions of this work by the primary laboratory is acceptable for special analysis, but subcontracting must be approved by the Montana DEQ Spring Meadow Lake site project manager, Mr. John Koerth. All laboratories in this project must abide by the LAP and the QAPP.

Confidentiality

Analytical results are to be held in the strictest of confidence and will be discussed with only those individuals approved by the Montana DEQ Spring Meadow Lake site project manager.

Reporting Times

Analytical results are to be reported within 30 working days of sample receipt by the laboratory. If at all possible, holding, analysis, and reporting times should be minimized.

Reporting Format

The data report package for the target analyte list (TAL) metals will not initially include a standard EPA Contract Laboratory Program (CLP) package, but the laboratory must save all the run data on magnetic media in order to generate a CLP package on request for a period of two years following completion of the analysis. The laboratory should obtain written permission from the Montana DEQ prior to disposing of any archived data support packages.

The data support package provided as a deliverable should include the following:

1. Cover letter documenting analytical protocols used.
2. Copies of completed chain-of-custody forms.
3. Cross-reference table of contractor and laboratory identification numbers.
4. Data summary tables (hard copy and electronic media in format to be negotiated between Tetra Tech EM Inc. and the laboratory).
5. QA/QC summaries including laboratory control samples (LCS), spikes, duplicates, and preparation blank results.

The physical parameters and other specialized chemical analyses, such as particle size, cation exchange capacity (CEC), and fertilizer and lime requirements, should comply with the above five components, when applicable.

Report Transmittal

All data reports are to be sent directly to Tetra Tech EM Inc., Power Block Building, 7 West 6th Avenue, Suite 612, Helena, Montana 59601, in care of Mr. J. Edward Surbrugg.

4.4.3 Quality Assurance Requirements

The mechanism used to monitor the precision and accuracy of environmental data is the analysis of field and laboratory QC samples. The required field QC types and frequency are provided in the QAPP. The required laboratory QC requirements are specified in this LAP when the CLP statement of work (SOW) for inorganics (EPA 1992), or the analytical method does not define the QC requirement. Laboratory QC includes method blanks, duplicates, matrix spikes, and LCS. These QC requirements are to be performed

at a frequency of 1 per 20 samples except for particle size analysis, components of the lime requirement, and CEC. The CEC will only have duplicates performed. The ranges for precision (duplicates) and accuracy (matrix spikes) acceptability are presented in the QAPP. The method blank should have a reported value within the method detection limit of the instrument detection limit.

Calibration procedures and sample preparation procedures are presented in the analytical method references listed in Table 4-8 when appropriate. There will be no referee laboratory or auditing of the main laboratory or the specialized laboratory (if applicable) for this project.

4.4.4 Analytical Methods

Analytical methods are summarized in Table 4-8 with the appropriate reference document(s). The project laboratories should contact Mr. Koerth or Mr. Reynolds for permission to deviate from the listed analytical methods for the project analyses.

Detection Limits

The instrumentation used must be sensitive enough to meet the required detection limits. Instruments for target analyte analyses are ICP, AA, and CVAA. The detection limits for the parameters presented in Tables 4-4 (Section 4.2.8) and 4-8 are included in the analytic reference methods.

Storage Requirements

The contracted laboratory is required to have a secured sample bank for storage of samples, digestates, and extracts. Original samples will be stored in the sample bank for a standard six month interval. All other forms of the sample to be analyzed will be stored in this area for the standard six month interval after analysis or to the end of the analyte holding time, whichever ever comes first. This will provide the Montana DEQ and Tetra Tech EM Inc. ample time to review data and request reanalysis if necessary. At the end of six months time, the laboratory will be responsible for sample disposal.

Chain-Of-Custody

A sample is physical evidence collected from a facility or from the environment. An essential part of hazardous waste investigations is that samples and data may be used as evidence in legal proceedings.

Laboratories performing analyses will use document control and chain-of-custody procedures as specified in Exhibit F for the CLP SOW for inorganics (EPA 1992).

Sample Stream

In accordance with EPA procedures, field QC samples (duplicates, blanks, and equipment rinsates) will be treated in the same manner as the natural samples. This provides external QC checks of laboratory data.

4.5 HEALTH AND SAFETY PLAN

The health and safety plan for RI activities at the Spring Meadow Lake site begins on the next page.

HEALTH AND SAFETY PLAN

Site Name: SPRING MEADOW LAKE SITE	Site Contact: J. Edward Surbrugg, Tetra Tech EM Inc.	Telephone: (406) 442-5588												
Location: On the west side of Helena, Montana	Client Contact: John Koerth, MWCB	Telephone: (406) 841-5026												
EPA I.D. No.: Not Applicable	Prepared By: Jessica Allewalt, Tetra Tech EM Inc.	Date: 03/1/05												
Project No. S1129-30SML SRI	Date of Proposed Activities: April-May 2005													
Objectives: The Spring Meadow Lake site is an abandoned mill and mineral processing facility located on the west side of Helena, MT. Portions of the site are on a State Park and portions are on the Montana Wildlife Center property. The Montana DEQ/MWCB is currently preparing plans for mitigating environmental impacts associated with the tailings, mineral processing wastes, and contaminated soils on this site.	Site Type: Check as many as applicable. <table><tr><td>☐ Active</td><td>☐ Confined space</td><td>☐ Well field</td></tr><tr><td>☒ Inactive</td><td>☐ Landfill</td><td>☐ Unknown</td></tr><tr><td>☐ Secure</td><td>☒ Uncontrolled</td><td>☐ Underground storage tank</td></tr><tr><td>☒ Unsecure</td><td>☐ Industrial</td><td>☒ Other (specify) Abandoned mine site</td></tr></table>		☐ Active	☐ Confined space	☐ Well field	☒ Inactive	☐ Landfill	☐ Unknown	☐ Secure	☒ Uncontrolled	☐ Underground storage tank	☒ Unsecure	☐ Industrial	☒ Other (specify) Abandoned mine site
☐ Active	☐ Confined space	☐ Well field												
☒ Inactive	☐ Landfill	☐ Unknown												
☐ Secure	☒ Uncontrolled	☐ Underground storage tank												
☒ Unsecure	☐ Industrial	☒ Other (specify) Abandoned mine site												

Site Description and History:

The Spring Meadow Lake site is located within the city limits on the west side of Helena, Montana, in Lewis & Clark County, Montana. Milling and mineral processing operations commenced in the early 1900s and ceased in 1920. Gravel mining activities at the site commenced in the 1920s and ceased approximately four decades later. The project site is situated at an elevation between approximately 3,950 feet above mean sea level in Section 23, Township 10 North, Range 4 West, Montana principle meridian (Latitude North 46° 36' 30"; Longitude West 112° 04' 30") The project site includes several old building and lake located within an abandoned gravel mining pit.

Note: A site map is provided on Page 4-50. Definitions and additional information about this form are provided on Page 4-52.

HEALTH AND SAFETY PLAN

Waste Management Practices:

Tetra Tech EM Inc. investigated the Spring Meadow Lake site in 2004 in order to complete a site inspection and hazardous materials inventory (DEQ-MWCB 2004). The volume of tailings and other mineral processing wastes associated with the Spring Meadow Lake site was estimated at 10,000 cubic yards. Wet tailings were observed in a subsurface pit or sump during the investigation. The total impacted area at the site is estimated at 20 acres.

Analysis of solid-matrix samples (which included wet tailings) collected during the inventory indicates that the tailings and mineral processing waste materials contain elevated concentrations of arsenic (up to 52,228 milligrams per kilogram [mg/kg]), copper (up to 28,952 mg/kg), lead (up to 25,661mg/kg), manganese (up to 293,133 mg/kg), and zinc (up to 42,657 mg/kg).

Waste Types:	☐ Liquid	☒ Solid	☐ Sludge	☐ Gas	☐ Unknown	☐ Tailings
Waste Characteristics:	☐ Corrosive ☒ Toxic ☐ Inert ☐ Ignitable ☐ Flammable ☐ Volatile ☐ Reactive ☐ Radioactive ☐ Unknown ☐ Other (specify) _____					
Hazards of Concern:	☒ Heat stress ☒ Cold stress ☐ Explosion or fire hazard ☐ Oxygen deficiency ☐ Radiological hazard ☐ Underground storage tanks ☐ Surface tanks ☒ Buried utilities ☒ Overhead utilities ☐ Biological hazard ☐ Noise ☒ Inorganic chemicals ☐ Organic chemicals ☒ Heavy equipment ☒ Other (specify) <u>Wood and metal debris, steep slopes, and loose rock and soil</u>					
Explosion or Fire Potential:	☐ High	☐ Medium	☒ Low	☐ Unknown		

HEALTH AND SAFETY PLAN

Chemical Products Tetra Tech EM Inc. Will Use or Store On Site: (Attach a Material Safety Data Sheet [MSDS] for each item.)

☒ Alconox® or Liquinox®

☐ Hydrochloric acid (HCl)

☒ Nitric Acid (HNO₃)

☐ Sodium hydroxide (NaOH)

☒ Sulfuric Acid (H₂SO₄)

☐ Other (specify) _____

☐ Other (specify) _____

☐ Other (specify) _____

☐ Other (specify) _____

☐ Other (specify) _____

☐ Other (specify) _____

☐ Other (specify) _____

☐ Other (specify) _____

HEALTH AND SAFETY PLAN

Chemicals Present at Site	Highest Observed Concentration (specify units and media)	PEL/TLV (specify ppm or mg/m ³)	IDLH Level (specify ppm or mg/m ³)	Symptoms and Effects of Acute Exposure	Photo-ionization Potential (eV)
Arsenic	52,228 mg/kg	0.01 mg/m ³	5 mg/m ³	Ulceration of nasal septum, dermatitis, gastrointestinal disturbances, peripheral neuropathy, respiratory irritation, hyperpigmentation of skin; potential occupational carcinogen	NA
Cadmium	326 mg/kg	0.005 mg/m ³	9 mg/m ³	Pulmonary edema, dyspnea, cough, chest tightness, substernal pain; headache; chills, muscular aches; nausea, vomiting, diarrhea; anosmia, emphysema, proteinuria, mild anemia, potential occupational carcinogen	NA
Chromium	56 mg/kg	1 mg/m ³	250 mg/m ³	Irritation of the eyes, skin, and lungs; fibrosis (histologic)	NA
Copper	28,952 mg/kg	1 mg/m ³	100 mg/m ³	Irritation of eyes, nose, pharynx; nasal perforation, metallic taste, dermatitis	NA
Lead	25,661 mg/kg	0.05 mg/m ³	100 mg/m ³	Weakness, lassitude, insomnia; facial pallor; pal eye, anorexia, low-weight, malnutrition; constipation, abdominal pain, colic; anemia; gingival lead line; tremor; wrist and ankle paralysis; encephalopathy; nephropathy; irritation of eyes; hypotension	NA
Manganese	293,133 mg/kg	5 mg/m ³	500 mg/m ³	Parkinson's disease; asthenia, insomnia, mental confusion; metal fume fever; dry throat, cough, chest tightness, dyspnea, rales, flu-like fever; low-back pain; vomiting; malaise; fatigue; kidney damage	NA
Mercury	3.9 mg/kg	0.1 mg/m ³	10 mg/m ³	Cough, chest pain, dyspnea, bronchitis pneumonitis; tremor, insomnia; irritability, indecision; headache, fatigue, weakness; stomatitis, salivation, gastrointestinal disturbance, anorexia, low-weight; proteinuria; irritation of eyes and skin	NA
Zinc	42,657 mg/kg	5 mg/m ³	500 mg/m ³	Sweet, metallic taste; dry throat, cough; chills, fever; tight chest, dyspnea, rales, reduced pulmonary function; headache; blurred vision; muscle cramps, lower back pain; nausea, vomiting; fatigue, lassitude, malaise	NA
Notes:					
A = Air		GW = Groundwater		ppm = Part per million	
CARC = Carcinogenic		IDLH = Immediately dangerous to life or health		S = Soil	
eV = Electron volt		mg/m ³ = Milligram per cubic meter		SW = Surface water	
		NA = Not available		TLV = Threshold limit value	
		NE = Not established		U = Unknown	
		PEL = Permissible exposure limit			

HEALTH AND SAFETY PLAN

Field Activities Covered Under This Plan:				
Task Description	Type	Level of Protection		Date of Activities
		Primary	Contingency	
1 Surface soil, sediment, and surface water sample collection.	☒ Intrusive ☐ Nonintrusive	☐ C ☐ Modified	☐ C ☒ Modified	March-June 2005
2 Subsurface soil sample collection (test pits - backhoe).	☒ Intrusive ☐ Nonintrusive	☐ C ☒ Modified	☐ C ☒ Modified	March-June 2005
Site Personnel and Responsibilities (include subcontractors):				
Employee Name and Office Code	TASK	Responsibilities		
J. Edward Surbrugg, Tetra Tech EM Inc. (HE)	All	Project Manager: Directs project investigation activities, makes site safety coordinator (SSC) aware of pertinent project developments and plans, and maintains communications with client as necessary.		
Chris Reynolds, Tetra Tech EM Inc. (HE)	All	Site Safety Coordinator (SSC): Ensures that appropriate personal protective equipment (PPE) is available, enforces proper utilization of PPE by on-site personnel, suspends investigative work if he or she believes that site personnel are or may be exposed to an immediate health hazard, implements the health and safety plan, and reports any observed deviations from anticipated conditions described in the health and safety plan to the health and safety representative.		
Joe Faubion, Tetra Tech EM Inc. (HE)	All	Field Team Leader, Project Engineer, and Field Personnel: Complete tasks as directed by the project manager, field team leader, and SSC and follow all procedures and guidelines established in the Tetra Tech, EM Inc. Health and Safety Manual.		
Gary Sturm, Tetra Tech EM Inc. (HE), Project Engineer	All			
Laura Newman, Tetra Tech EM Inc. (HE), Field Team Member	All			
Matt Hulbert, Tetra Tech EM Inc. (HE), Engineering Design Support	All			
Aaron Cade, Tetra Tech EM Inc. (HE), Technical Support, Site Map and Volume Estimates	All			
Jessica Allowalt, Tetra Tech EM Inc. (HE), Field Team Member	All			

HEALTH AND SAFETY PLAN

Protective Equipment: (Indicate type or material as necessary for each task; attach additional sheets as necessary)			
Task:	☒ 1	☒ 2	
Level:	☐ C	☒ D	
☒ Primary	☐ Contingency	☐ Modified	☐ Contingency
RESPIRATORY ☒ Not needed ☐ APR: _____ ☐ Cartridge: <u>HEPA</u> ☐ Escape mask: _____ ☐ Other: _____ PROTECTIVE CLOTHING ☒ Not needed ☐ Tyvek® coveralls: _____ ☐ Saranex® coveralls: _____ ☐ Coveralls: _____ ☐ Other: _____			
HEAD AND EYE ☐ Not needed ☒ Safety glasses: <u>As Required</u> ☐ Face shield: _____ ☐ Goggles: _____ ☒ Hard hat: <u>As Required</u> ☐ Other: _____ GLOVES ☐ Not needed ☒ Undergloves: <u>Latex</u> ☒ Gloves: <u>Leather</u> ☐ Overgloves: _____			
FIRST AID EQUIPMENT ☐ Not needed ☒ Standard First Aid kit ☐ Portable eyewash BOOTS ☐ Not needed ☒ Work boots: <u>Steel-Toe/Steel Shank</u> ☐ Overboots: _____			
OTHER (specify): _____			
RESPIRATORY ☒ Not needed ☐ APR: _____ ☐ Cartridge: <u>HEPA</u> ☐ Escape mask: _____ ☐ Other: _____ PROTECTIVE CLOTHING ☐ Not needed ☒ Tyvek® coveralls: _____ ☐ Saranex® coveralls: _____ ☐ Coveralls: _____ ☐ Other: _____			
HEAD AND EYE ☐ Not needed ☒ Safety glasses: _____ ☐ Face shield: _____ ☐ Goggles: _____ ☒ Hard hat: _____ ☐ Other: _____ GLOVES ☐ Not needed ☒ Undergloves: <u>Latex</u> ☒ Gloves: <u>Nitrile</u> ☐ Overgloves: _____			
FIRST AID EQUIPMENT ☐ Not needed ☒ Standard First Aid kit ☐ Portable eyewash BOOTS ☐ Not needed ☒ Work boots: <u>Steel-Toe/Steel Shank</u> ☐ Overboots: _____			
OTHER (specify): _____			

Note: APR = Air purifying respirator

HEALTH AND SAFETY PLAN

Monitoring Equipment: (Specify instruments needed for each task; attach additional sheets as necessary)

Instrument	Task	Instrument Reading	Action Guideline	Comments
Combustible gas indicator model:	☐ 1	0 to 10% LEL	No explosion hazard	☒ Not needed
	☐ 2	10 to 25% LEL > 25% LEL	Potential explosion hazard; notify SSC Explosion hazard; interrupt task; evacuate site; notify SSC	
O2 meter model:	☐ 1	> 23.5% O2	Potential fire hazard; evacuate site	☒ Not needed
	☐ 2	23.5 to 19.5% O2 < 19.5% O2	Oxygen level normal Oxygen deficiency; interrupt task; evacuate site; notify SSC	
Radiation survey meter model:	☐ 1	< 2 mrem per hour	Normal background	Note: Annual exposure not to exceed 1,250 mrem per quarter
	☐ 2	Three times background > 2 mrem per hour	Notify SSC Radiological hazard; interrupt task; evacuate site; notify SSC	
Photoionization detector model: ☐ 11.7 eV ☐ 10.2 eV ☐ 9.8 eV ☐ eV	☐ 1	>0 to 5 ppm above background	Level D	☒ Not needed
	☐ 2	>5 to 20 ppm above background >20 ppm above background	Level C Evacuate site; notify SSC	
Flame ionization detector model:	☐ 1	>0 to 5 ppm above background	Level D	☒ Not needed
	☐ 2	>5 to 20 ppm above background >20 ppm above background	Level C Evacuate site; notify SSC	
Detector tubes models:	☐ 1	Specify:	Specify:	Note: This action level for upgrading the level of protection is one-half of the contaminant's PEL. If the PEL is reached, evacuate the site and notify the SSC.
	☐ 2			
Respirable dust monitor model:	☐ 1 ☐ 2	Specify:	Specify:	☒ Not needed
Other: (specify):	☐ 1 ☐ 2	Specify:	Specify:	☐ Not needed

Notes: eV = Electron volt

LEL = Lower explosive limit

mrem = Millirem

O₂ = Oxygen

PEL = Permissible exposure limit

ppm = Part per million

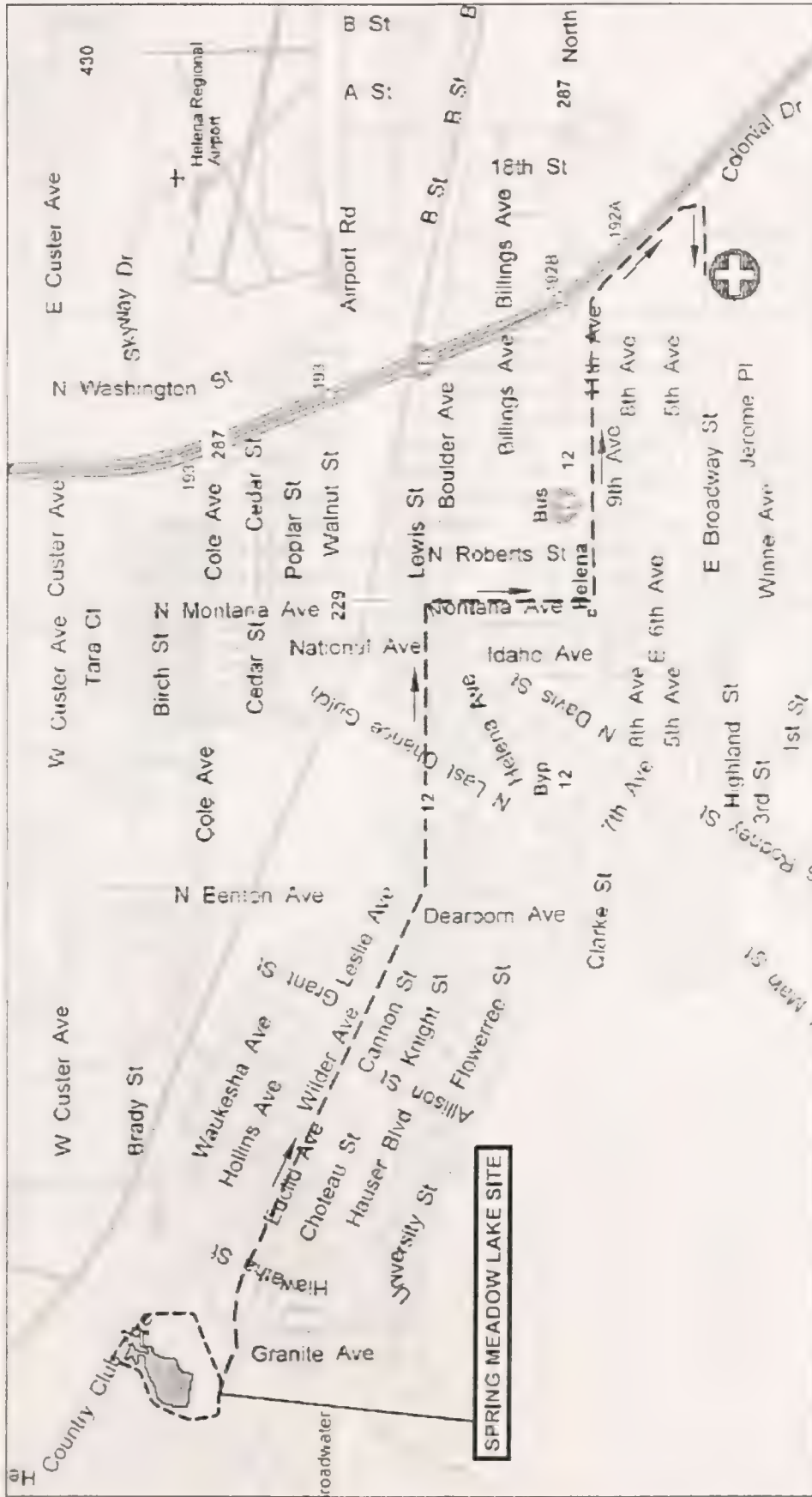
HEALTH AND SAFETY PLAN

Additional Comments:	Emergency Contacts:	Telephone
	U.S. Coast Guard National Response Center InfoTrac Fire department Police department Tetra Tech EM Inc. Personnel: Human Resource Development: Norman Endlich Health & Safety Representative: Judith Wagner Office Health and Safety Coordinator Project Manager Site Safety Coordinator	800/424-8801 800/535-5053 911 911 703/390-0626 847/818-7192 442-5588 442-5588 421-4549 (cell phone)
Personnel Decontamination and Disposal Method: Personnel will follow the U.S. Environmental Protection Agency's "Standard Operating Safety Guides" for decontamination procedures for Modified Level D personal protection (with Level D contingency). The following decontamination steps should be employed for this project: • Disposable gloves • Safety glasses and hard hat • Hand and face wash and rinse (portable water jugs and paper towels) If site conditions require upgrading to Level D, Tyvek coveralls, boot covers, and undergloves will be added to the standard PPE. All disposable equipment, clothing, and wash water will be double-bagged or containerized in an acceptable manner and disposed of in accordance with local regulations.	Medical Emergency: Hospital Name: St. Peters Hospital Hospital Address: 2475 Broadway, Helena, MT 59601 Hospital Telephone: Emergency - 911 General - 442-2480 Ambulance Telephone: 911 or 444-2228 Route to Hospital: (see Page 4-50 for route map) Exit Spring Meadow Lake site and turn east (left) onto Hwy 12 (Euclid Ave.). Follow Hwy 12 east until it becomes Montana Ave. Continue north on Montana Ave. and proceed to 11 th Ave. Turn east (left) onto 11 th Ave and proceed about 0.75 mile to Colonial Drive exit. Proceed about 0.75 miles on Colonial Drive until it intersects with East Broadway. Turn right (west) onto Broadway and St. Peter's Hospital is located on the left.	

Note: This page must be posted on site.

HEALTH AND SAFETY PLAN

Hospital Route Map (if available):



HEALTH AND SAFETY PLAN

APPROVAL AND SIGN-OFF FORM

Project No. S1129-06BLUERI

I have read, understood, and agree with the information set forth in this Health and Safety Plan and will follow the direction of the Site Safety Coordinator as well as procedures and guidelines established in the Tetra Tech, Inc., Health and Safety Manual. I understand the training and medical requirements for conducting field work and have met these requirements.

_____ Name	_____ Signature	_____ Date
_____ Name	_____ Signature	_____ Date
_____ Name	_____ Signature	_____ Date
_____ Name	_____ Signature	_____ Date

APPROVALS: (Two Signatures Required)

_____ Site Safety Coordinator	_____ Date
_____ Health and Safety Representative or Designee	_____ Date

HEALTH AND SAFETY PLAN

DEFINITIONS

Intrusive - Work involving excavation to any depth, drilling, opening of monitoring wells, most sampling, and Geoprobe® work

Nonintrusive - Generally refers to site walk-throughs or field reconnaissance

Levels of Protection

Modified Level D - Hard hat, safety boots, and glasses

Level D - Items listed for modified Level D above, **PLUS** protective clothing such as gloves, boot covers, and Tyvek® or Saranex® coveralls

Modified Level C - Hard hat, safety boots, glasses, and air purifying respirators with appropriate cartridges

Level C - Items listed for modified Level C above, **PLUS** protective clothing such as gloves, boot covers, and Tyvek® or Saranex® coveralls

Emergency Contacts

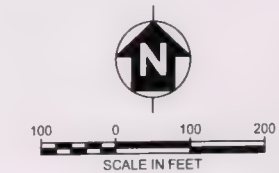
InfoTrac - For issues related to incidents involving the transportation of hazardous chemicals; this hotline provides accident assistance 24 hours per day, 7 days per week
U.S. Coast Guard National Response Center - For issues related to spill containment, cleanup, and damage assessment; this hotline will direct spill information to the appropriate state or region

Health and Safety Plan Short Form

- Used for field projects of limited duration and with relatively limited activities; may be filled in with handwritten text
- Limitations:
 - No Level B or A work
 - No more than two tasks
 - No confined space entry
 - No unexploded ordnance work

4.6 REFERENCES CITED

- American Society of Agronomy. 1996. *Methods of Soil Analysis, Part 3, Chemical Methods*. Number 5 in the Soil Science Society of America Book Series, Madison, WI. 1390 p.
- American Society for Testing and Materials. 1985. *Standard Practice for Particle-Size Analysis and Determination of Soil Constants*.
- DEQ-MWCB, 2004. Abandoned Hard Rock Mine Priority Site Investigation and Hazardous Materials Inventory. Spring Meadow Site, Lewis and Clark County, PA 25-505. (Tetra Tech EM Inc.)
- Montana Department of Environmental Quality (DEQ). 2004. Montana Numeric Water Quality Standards (Circular WQB-7). January.
- Tetra Tech, Inc. 1996. "Risk Based Cleanup Guidelines for Abandoned Mine Sites: Final Report." Prepared for the Department of Environmental Quality, Abandoned Mine Reclamation Bureau. February.
- U.S. Environmental Protection Agency (EPA). 1974. *Mine Spoil Potentials for Soil and Water Quality*. EPA 670/2-74-070. Cincinnati, OH.
- EPA. 1978. *Field and Laboratory Methods Applicable to Overburdens and Mine Soils*. EPA 600/2-78-054. Cincinnati, OH.
- EPA. 1986. *National Enforcement Investigations Center Policies and Procedures*. EPA 300/9-78-001-R.
- EPA. 1988. *Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analysis*.
- EPA. 1992. *U.S. EPA Contract Laboratory Program, Statement of Work, Inorganic Analysis, Multimedia, Multiconcentration*. Document ILM02.0.
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- EPA. 1999. *Methods and Guidance for the Analysis of Water, Version 2 (includes EPA Series 500, 600, 1600 Methods)*. Washington, D.C.,
- Washington State Department of Ecology. 1997. *Creation and Analysis of Freshwater Sediment Quality Values in Washington State*. Publication No. 97-323a, Department of Ecology Publications Distributions Office, Olympia, Washington. July.



Tt Tetra Tech EM Inc.

Spring Meadow Lake
Helena, Montana

**FIGURE 4-1
EXISTING AND PROPOSED
SAMPLE LOCATION MAP**

ATTACHMENT 1

**MONITORING WELL INSTALLATION
SOP NO. 020**

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

MONITORING WELL INSTALLATION

SOP NO. 020

REVISION NO. 3

Last Reviewed: December 2000

K. Miesing

Quality Assurance Approved

December 19, 2000

Date

1.0 BACKGROUND

Groundwater monitoring wells are designed and installed for a variety of reasons including: (1) detecting the presence or absence of contaminants, (2) collecting groundwater samples representative of in situ aquifer chemical characteristics, or (3) measuring water levels for determining groundwater potentiometric head and groundwater flow direction.

Although detailed specifications for well installation may vary in response to site-specific conditions, some elements of well installation are common to most situations. This standard operating procedure (SOP) discusses common methods and minimum standards for monitoring well installation for Tetra Tech EM Inc. (Tetra Tech) projects. The SOP is based on widely recognized methods described by the U.S. Environmental Protection Agency (EPA) and American Society for Testing and Materials (ASTM). However, well type, well construction, and well installation methods will vary with drilling method, intended well use, subsurface characteristics, and other site-specific criteria. In addition, monitoring wells should be constructed and installed in a manner consistent with all local and state regulations. Detailed specifications for well installation should be identified within a site-specific work plan, sampling plan, or quality assurance project plan (QAPP).

General specifications and installation procedures for the following monitoring well components are included in this SOP:

- Monitoring well materials
 - Casing materials
 - Well screen materials
 - Filter pack materials
 - Annular sealant (bentonite pellets or chips)
 - Grouting materials
 - Tremie pipe
 - Surface completion and protective casing materials
 - Concrete surface pad and bumper posts
 - Uncontaminated water
- Monitoring well installation procedures
 - Well screen and riser placement
 - Filter pack placement
 - Temporary casing retrieval
 - Annular seal placement

- Grouting
 - Surface completion and protective casing (aboveground and flush-mount)
 - Concrete surface pad and bumper posts
 - Permanent and multiple casing well installation
- Recordkeeping procedures
 - Surveying
 - Permits and well construction records
 - Monitoring well identification

Well installation methods will depend to some extent on the boring method. Specific boring or drilling protocols are detailed in other SOPs. The boring method, in turn, will depend on site-specific geology and hydrogeology and project requirements. Boring methods commonly used for well installation include:

- Hollow-stem augering
- Cable tool drilling
- Mud rotary drilling
- Air rotary drilling
- Rock coring

The hollow-stem auger method is preferred in areas where subsurface materials are unconsolidated or loosely consolidated and where the depth of the boring will be less than 100 feet. This maximum effective depth for hollow-stem augering depends on the diameter of the augers, the formation characteristics, and the strength and durability of the drilling equipment. This method is preferred because under the right conditions it is cost effective, addition of water into the subsurface is limited, continuous soil samples can easily be collected, and monitoring wells can easily be constructed within the hollow augers.

Cable tool drilling is a preferred method when the subsurface contains boulders, coarse gravels, or flowing sands, or when the operational depth of the hollow-stem auger is exceeded. However, this method is slow.

Rotary methods are generally used when other methods cannot be used. The use of drilling fluids or large amounts of water to maintain an open borehole, and the difficulty in obtaining representative

samples limit the utility of rotary methods. However, rotary methods can be used to quickly and effectively drill deep wells through consolidated or unconsolidated materials. Modifications to this method such as dual-tube drilling procedures, drill-through casing hammers, or eccentric-type drill systems, can reduce the amount of fluids introduced into the well borehole.

Rock coring is an effective method when drilling in competent consolidated rock. Intact, continuous cores can be obtained, and limited amounts of fluid are required if the formations are not fractured.

1.1 PURPOSE

This SOP establishes the requirements and procedures for monitoring well installation. Monitoring wells should be designed to function properly throughout the duration of the monitoring program. The performance objectives for monitoring well installation are as follows:

- Ensure that the monitoring well will provide water samples representative of in situ aquifer conditions.
- Ensure that the monitoring well construction will last for duration of the project.
- Ensure that the monitoring well will not serve as a conduit for vertical migration of contaminants, particularly vertical migration between discrete aquifers.
- Ensure that the well diameter is adequate for all anticipated downhole monitoring and sampling equipment.

1.2 SCOPE

This SOP applies to the installation of monitoring wells. Although some of the procedures may apply to the installation of water supply wells, this SOP is not intended to cover the design and construction of such wells. The SOP identifies several well drilling methods related to monitoring well installation, but the scope of this SOP does not include drilling methods.

Other relevant SOPs include SOP 002 for decontamination of drilling and well installation equipment, SOP 005 for soil sampling, SOP 021 for monitoring well development, SOPs 010 and 015 for

groundwater sampling from monitoring wells, and SOP 014 for measuring static water levels within monitoring wells.

1.3 DEFINITIONS

Annulus: The space between the monitoring well casing and the wall of the well boring.

Bentonite seal: A colloidal clay seal separating the sand pack from the annular grout seal.

Centralizer: A stainless-steel or plastic spacer that keeps the well screen and casing centered in the borehole.

Filter pack: A clean, uniform sand or gravel placed between the borehole wall and the well screen to prevent formation material from entering the screen.

Grout seal: A fluid mixture of (1) bentonite and water, (2) cement, bentonite, and water, or (3) cement and water placed above the bentonite seal between the casing and the borehole wall to secure the casing in place and keep water from entering the borehole.

Tremie pipe: A rigid pipe used to place the well filter pack, bentonite seal, or grout seal. The tremie pipe is lowered to the bottom of the well or area to be filled and pulled up ahead of the material being placed.

Well casing: A solid piece of pipe, typically polyvinyl chloride (PVC) or stainless steel, used to keep a well open in either unconsolidated material or unstable rock.

Well screen: A PVC or stainless steel pipe with openings of a uniform width, orientation, and spacing used to keep materials other than water from entering the well and to stabilize the surrounding formation.

1.4 REFERENCES

- American Society for Testing and Materials. 1995. Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers. D5092-90. West Conshohocken, Pennsylvania.
- California Department of Toxic Substances Control. 1994. Monitoring Well Design and Construction for Hydrogeologic Characterization. Guidance for Groundwater Investigations. August.
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- U.S. Environmental Protection Agency (EPA). 1986. RCRA Ground Water Monitoring Technical Enforcement Guidance Document. Office of Solid Waste and Emergency Response. Washington, DC. OSWER-9950-1. September.
- EPA. 1991. Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells. Office of Research and Development, Environmental Monitoring Systems Laboratory. Washington, DC. EPA/600-4-89/034. March. On-Line Address: <http://www.epa.gov/swerust1/cat/wwelldct.pdf>
- EPA. 1994. Monitor Well Installation. Environmental Response Team SOP #2048 (Rev. #0.0. 03/18/96). On-Line Address: http://www.ert.org/media_resrcs/media_resrcs.asp?Child1=

1.5 REQUIREMENTS AND RESOURCES

Well installation requires a completed boring with stable or supported walls. The type of drilling rig needed to complete the boring and the well construction materials required for monitoring well installation will depend on the drilling method used, the geologic formations present, and chemicals of concern in groundwater. The rig and support equipment used to drill the borehole is usually used to install the well. Under most conditions, the following items are also required for the proper installation of monitoring wells:

- Tremie pipe and funnel
- Bentonite pellets or chips
- Grouting supplies
- Casing materials
- Well screen materials
- Filter pack materials

- Surface completion materials (protective casing, lockable and watertight well cover, padlock)
- Electronic water level sounding device for water level measurement
- Measuring tape with weight for measuring the depth of the well and determining the placement of filter pack materials
- Decontamination equipment and supplies
- Site-specific work plan, field sampling plan, health and safety plan, and QAPP
- Monitoring Well Completion Record (see Figure 1)

2.0 MONITORING WELL INSTALLATION PROCEDURES

This section presents standard procedures for monitoring well installation and is divided into three subsections. Section 2.1 addresses monitoring well construction materials, while Section 2.2 describes typical monitoring well installation procedures. Section 2.3 addresses recordkeeping requirements associated with monitoring well installation. Monitoring well installation procedures described in work plans, sampling plans, and QAPPs should be fully consistent with the procedures outlined in this SOP as well as any applicable local and state regulations and guidelines.

2.1 MONITORING WELL CONSTRUCTION MATERIALS

Monitoring well construction materials should be specified in the site-specific work plan as well as in the statement of work for any subcontractors assisting in the well installation. Well construction materials that come in contact with groundwater should not measurably alter the chemical quality of groundwater samples with regard to the constituents being examined. The riser, well screen, and filter pack and annular sealant placement equipment should be steam cleaned or high-pressure water cleaned immediately prior to well installation. Alternatively, these materials can be certified by the manufacturer as clean and delivered to the site in protective wrapping. Samples of the filter pack, annular seal, and mixed grout should be retained as a quality control measure until at least one round of groundwater sampling and analysis is completed.

This section discusses material specifications for the following well construction components: casing, well screen, filter pack, annular sealant (bentonite pellets or chips), grout, tremie pipes, surface

completion components (protective casing, lockable and water tight cap, and padlock), concrete surface pad, and uncontaminated water. Figure 2 shows the construction details of a typical monitoring well.

2.1.1 Casing Materials

The material type and minimum wall thickness of the casing should be adequate to withstand the forces of installation. If the casing has not been certified as clean by the manufacturer or delivered to and maintained in clean condition at the site, the casing should be steam cleaned or high-pressure water cleaned with water from a source of known chemistry immediately prior to installation (see Tetra Tech SOP No. 002). The ends of each casing section should be either flush-threaded or beveled for welding.

Schedule 40 or Schedule 80 PVC casing is typically used for monitoring well installation. Either type of casing is appropriate for monitoring wells with depths less than 100 feet below ground surface (bgs). If the well is deeper than 100 feet bgs, Schedule 80 PVC should be used.

Stainless steel used for well casing is typically Type 304 and is of 11-gauge thickness.

2.1.2 Well Screen Materials

Well screens should be new, machine-slotted or continuous wrapped wire-wound, and composed of materials most suited for the monitoring environment based on site characterization findings. Well screens are generally constructed of the same materials used for well casing (PVC or stainless steel). The screen should be plugged at the bottom with the same material as the well screen. Alternatively, a short (1- to 2-foot) section of casing material with a bottom (sump) should be attached below the screen. This assembly must be able to withstand installation and development stresses without becoming dislodged or damaged. The length of the slotted area should reflect the interval to be monitored.

If the well screen has not been certified as clean by the manufacturer or delivered to and maintained in clean condition at the site, the screen should be steam cleaned or high-pressure water cleaned with water from a source of known chemistry immediately prior to installation (see Tetra Tech SOP No. 002).

The minimum internal diameter of the well screen should be chosen based on the particular application. A minimum diameter of 2 inches is usually needed to allow for the introduction and withdrawal of sampling devices. Typical monitoring well screen diameters are 2 inches and 4 inches.

The slot size of the well screen should be determined relative to (1) the grain size of particles in the aquifer to be monitored and (2) the gradation of the filter pack material.

Screen length and monitoring well diameter will depend on site-specific considerations such as intended well use, contaminants of concern, and hydrogeology. Some specific considerations include the following:

- Water table wells should have screens of sufficient length and diameter to monitor the water table and provide sufficient sample volume under high and low water table conditions.
- Wells with low recharge should have screens of sufficient length and diameter so that adequate sample volume can be collected.
- Wells should be screened over sufficiently short intervals to allow for monitoring of discrete migration pathways.
- Where light nonaqueous-phase liquids (LNAPL) or contaminants in the upper portion of a hydraulic unit are being monitored, the screen should be set so that the upper portion of the water-bearing zone is below the top of the screen.
- Where dense nonaqueous-phase liquids (DNAPL) are being monitored, the screen should be set within the lower portion of the water-bearing zone, just above a relatively impermeable lithologic unit.
- The screened interval should not extend across an aquiclude or aquitard.
- If contamination is known to be concentrated within a portion of a saturated zone, the screen should be constructed in a manner that minimizes the potential for cross-contamination within the aquifer.
- If downhole geophysical surveys are to be conducted, the casing and screen must be of sufficient diameter and constructed of the appropriate material to allow for effective use of the geophysical survey tools.
- If aquifer tests are to be conducted in a monitoring well, the slot size must allow sufficient flux to produce the required drawdown and recovery. The diameter of the well must be sufficient to house the pump and monitoring equipment, and allow sufficient

water flux (in combination with the screen slot size) to produce the required drawdown or recovery.

2.1.3 Filter Pack Materials

The primary filter pack consists of a granular material of known chemistry and selected grain size and gradation. The filter pack is installed in the annulus between the well screen and the borehole wall. The grain size and gradation of the filter pack are selected to stabilize the hydrologic unit adjacent to the screen and to prevent formation material from entering the well during development. After development, a properly filtered monitoring well is relatively free of turbidity.

A secondary filter pack is a layer of material placed in the annulus directly above the primary filter pack and separates the filter pack from the annular sealant. The secondary filter pack should be uniformly graded fine sand, with 100 percent by weight passing through a No. 30 U.S. Standard sieve, and less than 2 percent by weight passing through a No. 200 U.S. Standard sieve.

2.1.4 Annular Sealant (Bentonite Pellets or Chips)

The materials used to seal the annulus may be prepared as a slurry or used as dry pellets, granules, or chips. Sealants should be compatible with ambient geologic, hydrogeologic, and climatic conditions and any man-induced conditions anticipated to occur during the life of the well.

Bentonite (sodium montmorillonite) is the most commonly used annular sealant and is furnished in sacks or buckets in powder, granular, pelletized, or chip form. Bentonite should be obtained from a commercial source and should be free of impurities that may adversely impact the water quality in the well. Pellets are compressed bentonite powder in roughly spherical or disk shapes. Chips are large, coarse, irregularly shaped units of bentonite. The diameter of the pellets or chips should be less than one-fifth the width of the annular space into which they will be placed in order to reduce the potential for bridging. Granules consist of coarse particles of unaltered bentonite, typically smaller than 0.2 inch in diameter. Bentonite slurry is prepared by mixing powdered or granular bentonite with water from a source of known chemistry.

2.1.5 Grouting Materials

The grout backfill that is placed above the bentonite annular seal is ordinarily liquid slurry consisting of either (1) a bentonite (powder, granules, or both) base and water, (2) a bentonite and Portland cement base and water, or (3) a Portland cement base and water. Often, bentonite-based grouts are used when flexibility is desired during the life of the well installation (for example, to accommodate freeze-thaw cycles). Cement- or bentonite-based grouts are often used when cracks in the surrounding geologic material must be filled or when adherence to rock units, or a rigid setting is desired.

Each type of grout mixture has slightly different characteristics that may be appropriate under various physical and chemical conditions. However, quick-setting cements containing additives are not recommended for use in monitoring well installation because additives may leach from the cement and influence the chemistry of water samples collected from the well.

2.1.6 Tremie Pipe

A tremie pipe is used to place the filter pack, annular sealant, and grouting materials into the borehole. The tremie pipe should be rigid, have a minimum internal diameter of 1.0 inch, and be made of PVC or steel. The length of the tremie pipe should be sufficient to extend to the full depth of the monitoring well.

2.1.7 Surface Completion and Protective Casing Materials

Protective casings that extend above the ground surface should be made of aluminum, steel, stainless steel, cast iron, or a structural plastic. The protective casing should have a lid with a locking device to prevent vandalism. Sufficient clearance, usually 6 inches, should be maintained between the top of the riser and the top of protective casing. A water-tight well cap should be placed on the top of the riser to seal the well from surface water infiltration in the event of a flood. A weep hole should be drilled in the casing a minimum of 6 inches above the ground surface to enable water to drain out of the annular space.

Flush-mounted monitoring wells (wells that do not extend above ground surface) require a water-tight protective cover of sufficient strength to withstand heavy traffic. The well riser should be fitted with a locking water-tight cap.

2.1.8 Concrete Surface Pad and Bumper Posts

A concrete surface pad should be installed around each well when the outer protective casing is installed. The surface pad should be formed around the well casing. Concrete should be placed into the formed pad and into the borehole (on top of the grout), typically to a depth of 1 to 3 feet bgs (depending on state, federal, and local regulations). The protective casing is then installed into the concrete. As a general guideline, if the well casing is 2 inches in diameter, the concrete pad should be 3 feet square and 4 inches thick. If the well casing is 4 inches in diameter, the pad should be 4 feet square and 6 inches thick. Round concrete pads are also acceptable.

The finished pad should be sloped so that drainage flows away from the protective casing and off the pad. The finished pad should extend at least 1 inch below grade. If the monitoring wells are located in high traffic areas, a minimum of three bumper posts should be installed around the pad to protect the well. Bumper posts, consisting of steel pipes 3 to 4 inches in diameter and at least 5 feet long, should be installed in a radial pattern around the protective casing, beyond the edges of the cement pad. The base of the bumper posts should be installed 2 feet bgs in a concrete footing; the top of the post should be capped or filled with concrete.

2.1.9 Uncontaminated Water

Water used in the drilling process, to prepare grout mixtures, and to decontaminate the well screen, riser, and annular sealant injection equipment, should be obtained from a source of known chemistry. The water should not contain constituents that could compromise the integrity of the monitoring well installation.

2.2 MONITORING WELL INSTALLATION PROCEDURES

This section describes the procedures used to install a single-cased monitoring well, with either temporary casing or hollow-stem augers to support the walls of the boring in unconsolidated formations. The procedures are described in the order in which they are conducted, and include: (1) placement of well screen and riser pipe, (2) placement of filter pack, (3) progressive retrieval of temporary casing, (4) placement of annular seal, (5) grouting, (6) surface completion and installation of protective casing, and (7) installation of concrete pad and bumper posts.

The additional steps necessary to install a well with permanent or multiple casing strings are described at the end of this section.

2.2.1 Well Screen and Riser Placement

After the total depth of the boring is confirmed and the well screen depth interval and the height of the aboveground completion are determined, the screen and riser is assembled from the bottom up as it is lowered down the hole. The following procedures should be followed:

1. Measure the total depth of the boring using a weighted tape.
2. Determine the length of screen and casing materials required to construct the well.
3. Assemble the well parts from the bottom up, starting with the well sump or cap, well screen, and then riser pipe. Progressively lower the assembled length of pipe.
4. The length of the assembled pipe should not extend above the top of the installation rig.

The well sump or cap, well screen, and riser should be certified clean by the manufacturer or should be decontaminated before assembly and installation. No grease, oil, or other contaminants should contact any portion of the assembly. Flush joints should be tightened, and welds should be water tight and of good quality. The riser should extend above grade and be capped temporarily to prevent entrance of foreign materials during the remaining well completion procedures.

When the well screen and riser assembly is lowered to the predetermined level, it may float and require a method to hold it in place. For borings drilled using cable tool or air rotary drilling methods, centralizers should be attached to the riser at intervals of between 20 and 40 feet.

2.2.2 Filter Pack Placement

The filter pack is placed after the well screen and riser assembly has been lowered into the borehole. The steps below should be followed:

1. Determine the volume of the annular space in the filter pack interval. The filter pack should extend from the bottom of the borehole to at least 2 feet above the top of the well screen.
2. Assemble the required material (sand pack and tremie pipe).
3. Lower a clean or decontaminated tremie pipe down the annulus to within 1 foot of the base of the hole.
4. Pour the sand down the tremie pipe using a funnel; pour only the quantity estimated to fill the first foot.
5. Check the depth of sand in the hole using a weighted tape.
6. Pull the drill casing up ahead of the sand to keep the sand from bridging.
7. Continue with this process (steps 4 through 6) until the filter pack is at the appropriate depth.

If bridging of the filter pack occurs, break out the bridge prior to adding additional filter pack material. For wells less than 30 feet deep installed inside hollow-stem augers, the sand may be poured in 1-foot lifts without a tremie pipe.

Sufficient measurements of the depth to the filter pack material and the depth of the bottom of the temporary casing should be made to ensure that the casing bottom is always above the filter pack. The filter pack should extend 2 feet above the well screen (or more if required by state or local regulations). However, the filter pack should not extend across separate hydrogeologic units. The final depth interval, volume, and type of filter pack should be recorded on the Monitoring Well Completion Record (Figure 1).

A secondary filter pack may be installed above the primary filter pack to prevent the intrusion of the bentonite grout seal into the primary filter pack. A measured volume of secondary filter material should be added to extend 1 to 2 feet above the primary filter pack. As with the primary filter pack, a secondary filter pack must not extend into an overlying hydrologic unit. An on-site geologist should evaluate the

need for a secondary filter pack by considering the gradation of the primary filter pack, the hydraulic head difference between adjacent units, and the potential for grout intrusion into the primary filter pack.

The secondary filter material is poured into the annular space through tremie pipe as described above. Water from a source of known chemistry may be added to help place the filter pack into its proper location. The tremie pipe or a weighed line inserted through the tremie pipe can be used to measure the top of the secondary filter pack as work progresses. The amount and type of secondary filter pack used should be recorded on the Monitoring Well Completion Record (Figure 1).

2.2.3 Temporary Casing Retrieval

The temporary casing or hollow-stem auger should be withdrawn in increments. Care should be taken to minimize lifting the well screen and riser assembly during withdrawal of the temporary casing or auger. It may be necessary to place the top head of the rig on the riser to hold it down. To limit borehole collapse in formations consisting of unconsolidated materials, the temporary casing or hollow-stem auger is usually withdrawn until the lowest point of the casing or auger is at least 2 feet, but no more than 5 feet, above the filter pack. When the geologic formation consists of consolidated materials, the lowest point of the casing or auger should be at least 5 feet, but no more than 10 feet, above the filter pack. In highly unstable formations, withdrawal intervals may be much less. After each increment, the depth to the primary filter pack should be measured to check that the borehole has not collapsed or that bridging has not occurred.

2.2.4 Annular Seal Placement

A bentonite pellet, chip, or slurry seal should be placed between the borehole and the riser on top of the primary or secondary filter pack. This seal retards the movement of grout into the filter pack. The thickness of the bentonite seal will depend on state and local regulations, but the seal should generally be between 3 and 5 feet thick.

The bentonite seal should be installed using a tremie pipe, lowered to the top of the filter pack and slowly raised as the bentonite pellets or slurry fill the space. Care must be taken so that bentonite pellets or

chips do not bridge in the augers or tremie pipe. The depth of the seal should be checked with a weighted tape or the tremie pipe.

If a bentonite pellet or chip seal is installed above the water level, water from a known source should be added to allow proper hydration of the bentonite. Sufficient time should be allowed for the bentonite seal to hydrate. The volume and thickness of the bentonite seal should be recorded on the Monitoring Well Completion Record (Figure 1).

2.2.5 Grouting

Grouting procedures vary with the type of well design. The volume of grout needed to backfill the remaining annular space should be calculated and recorded on the Monitoring Well Completion Record (Figure 1). The use of alternate grout materials, including grouts containing gravel, may be necessary to control zones of high grout loss. Bentonite grouts should not be used in arid regions because of their propensity to desiccate. Typical grout mixtures include the following:

- Bentonite grout: about 1 to 1.25 pounds of bentonite mixed with 1 gallon of water
- Cement-bentonite grout: about 5 pounds of bentonite and one 94-pound bag of cement mixed with 7 to 8 gallons of water
- Cement grout: one 94-pound bag of cement mixed with 6 to 7 gallons of water

The grout should be installed by gravity feed through a tremie pipe. The grout should be mixed in batches in accordance with the appropriate requirements and then pumped into the annular space until full-strength grout flows out at the ground surface without evidence of drill cuttings or fluid. The tremie pipe should then be removed to allow the grout to cure.

The riser should not be disturbed until the grout sets and cures for the amount of time necessary to prevent a break in the seal between the grout and riser. For bentonite grouts, curing times are typically around 24 hours; curing times for cement grouts are typically 48 to 72 hours. However, the curing time required will vary with grout content and climatic conditions. The curing time should be documented in the Monitoring Well Completion Record (Figure 1).

2.2.6 Surface Completion and Protective Casing

Aboveground completion of the monitoring well should begin once the grout has set (no sooner than 24 hours after the grout was placed). The protective casing is lowered over the riser and set into the cured grout. The protective casing should extend below the ground surface to a depth below the frost line (typically 3 to 5 feet, depending on local conditions). The protective casing is then cemented in place. A minimum of 6 inches of clearance should be maintained between the top of the riser and the protective casing. A 0.5-inch diameter drainage or weep hole should be drilled in the protective casing approximately 6 inches above the ground surface to enable water to drain out of the annular space between the casing and riser. A water-tight cap should be placed on top of the riser to seal the well from surface water infiltration in the event of a flood. A lock should be placed on the protective casing to prevent vandalism.

For flush-mounted monitoring wells, the well cover should be raised above grade and the surrounding concrete pad sloped so that water drains away from the cover. The flush-mount completion should be installed in accordance with applicable state and local regulations.

2.2.7 Concrete Surface Pad and Bumper Posts

The concrete pad installed around the monitoring well should be sloped so that the drainage will flow away from the protective casing and off the pad. The finished pad should extend at least 1 inch below grade. If the monitoring wells are located in high traffic areas, a minimum of three bumper posts should be installed in a radial pattern around the protective casing, outside the cement pad. Specifications for concrete surface pads and bumper posts are described in Section 2.1.8.

2.2.8 Permanent and Multiple Casing Well Installation

When wells are installed through multiple saturated zones, special well construction methods should be used to assure well integrity and limit the potential for cross-contamination between geologic zones. Generally, these types of wells are necessary if relatively impermeable layers separate hydraulic units. Two procedures that may be used are described below.

In the first procedure, the borehole is advanced to the base of the first saturated zone. Casing is then anchored in the underlying impermeable layer (aquitar) by advancing the casing at least 1 foot into the aquitar and grouting to the surface. After the grout has cured, a smaller diameter borehole is drilled through the grout. This procedure is repeated until the zone of interest is reached. After the zone is reached, a conventional well screen and riser are set. A typical well constructed in this manner is shown on Figure 3.

A second acceptable procedure involves driving a casing through several saturated layers while drilling ahead of the casing. However, this method is not acceptable when the driven casing may structurally damage a competent aquitar or aquiclude and result in cross-contamination of the two saturated layers. This method should also be avoided when highly contaminated groundwater or nonaqueous-phase contamination may be dragged down into underlying uncontaminated hydrologic units.

2.3 RECORDKEEPING PROCEDURES

Recordkeeping procedures associated with monitoring well installation are described in the following sections. These include procedures for surveying, obtaining permits, completing well construction records, and identifying monitoring wells.

2.3.1 Surveying

Latitude, longitude, and elevation at the top of the riser should be determined for each monitoring well. A permanent notch or black mark should be made on the north side of the riser. The top of the riser and ground surface should be surveyed.

2.3.2 Permits and Well Construction Records

Local and state regulations should be reviewed prior to monitoring well installation, and any required well permits should be in-hand before the driller is scheduled.

Monitoring well installation activities should be documented in both the field logbook and on the Monitoring Well Completion Record (Figure 1). Geologic logs should be completed and, if necessary, filed with the appropriate regulatory agency within the appropriate time frame.

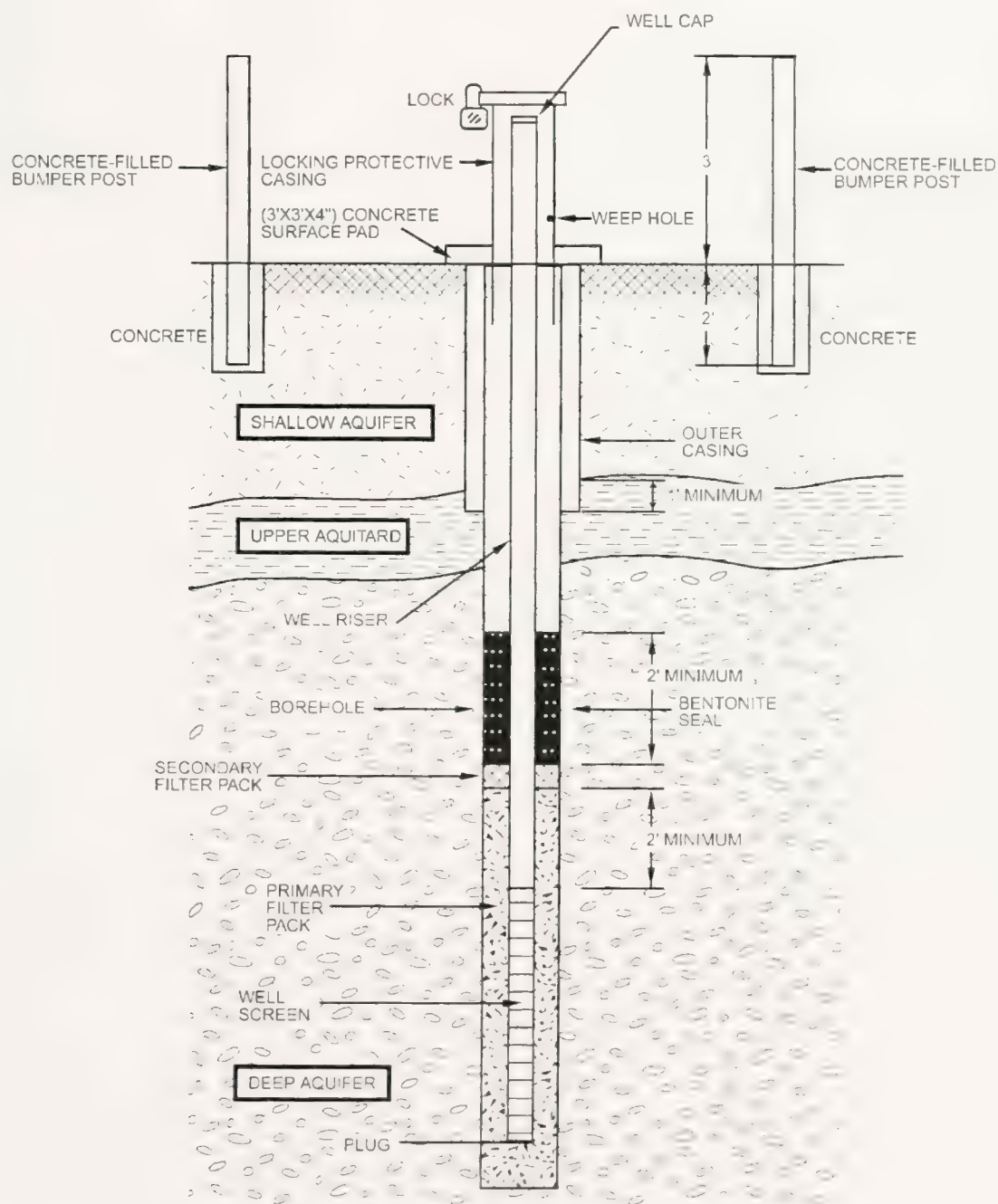
2.3.3 Monitoring Well Identification

Each monitoring well should have an individual well identification number or name. The well identification may be stamped in the metal surface upon completion or permanently marked by using another method. Current state and local regulations should be checked for identification requirements (such as township, range, section, or other identifiers in the well name).

FIGURE 1
MONITORING WELL COMPLETION RECORD

TETRATECH EM INC.		MONITORING WELL COMPLETION RECORD	
MONITORING WELL MONITORING WELL NO. _____ PROJECT _____ SITE _____ BOREHOLE NO. _____ WELL PERMIT NO. _____ TOC TO BOTTOM OF WELL _____		SURFACE COMPLETION ☐ FLUSH MOUNT ☐ ABOVE GROUND WITH BUMPER POST ☐ CONCRETE ☐ ASPHALT	
DRILLING INFORMATION DRILLING BEGAN DATE _____ TIME _____ WELL INSTALLATION BEGAN DATE _____ TIME _____ WELL INSTALLATION FINISHED DATE _____ TIME _____ DRILLING CO. _____ DRILLER _____ LICENSE _____ DRILL R/G _____ DRILLING METHOD ☐ HOLLOW STEMAUGER ☐ AIR ROTARY ☐ OTHER _____ DIAMETER OF AUGERS ID _____ OD _____		SURVEY INFORMATION TOC ELEVATION _____ GROUND SURFACE ELEVATION _____ NORTHING _____ EASTING _____ DATE SURVEYED _____ SURVEY CO. _____	
WELL CASING ☐ SCHEDULE 40 PVC ☐ OTHER _____ PRODUCT _____ MFG. BY _____ CASING DIAMETER ID _____ OD _____ LENGTH OF CASING _____		ANNULAR SEAL VOLUME CALCULATED _____ AMOUNT USED _____ ☐ GROUT FORMULA (PERCENTAGES) PORTLAND CEMENT _____ BENTONITE _____ WATER _____ ☐ PREPARED MIX PRODUCT _____ MFG. BY _____ METHOD INSTALLED ☐ POURED ☐ TREMIE ☐ OTHER _____	
WELL SCREEN ☐ SCHEDULE 40 PVC ☐ OTHER _____ PRODUCT _____ MFG. BY _____ CASING DIAMETER ID _____ OD _____ SLOT SIZE _____ LENGTH OF SCREEN _____		BENTONITE SEAL VOLUME CALCULATED _____ AMOUNT USED _____ ☐ PELLETS SIZE _____ ☐ CHIPS SIZE _____ ☐ OTHER _____ PRODUCT _____ MFG. BY _____ METHOD INSTALLED ☐ POURED ☐ TREMIE ☐ OTHER _____ AMOUNT OF WATER USED _____	
BOREHOLE BACKFILL AMOUNT CALCULATED _____ AMOUNT USED _____ ☐ BENTONITE CHIPS SIZE _____ ☐ BENTONITE PELLETS SIZE _____ ☐ SLURRY _____ ☐ FORMATION COLLAPSE _____ ☐ OTHER _____ PRODUCT _____ MFG. BY _____ METHOD INSTALLED ☐ POURED ☐ TREMIE ☐ OTHER _____		FILTER PACK ☐ PREFABRICATED FILTER VOLUME CALCULATED _____ AMOUNT USED _____ ☐ SAND SIZE _____ PRODUCT _____ MFG. BY _____ METHOD INSTALLED ☐ POURED ☐ TREMIE ☐ OTHER _____ WATER LEVEL _____ BTU AFTER WELL INSTALLATION	
CENTRALIZERS USED? ☐ YES ☐ NO CENTRALIZER DEPTHS _____		LEGEND BGS = BELOW GROUND SURFACE BTG = BELOW TOP OF CASING N/A = NOT APPLICABLE NR = NOT RECORDED MD = TOP OF COLLAPSE ID = INSIDE DIAMETER OD = OUTSIDE DIAMETER	

FIGURE 3
MULTIPLE CASING WELL CONSTRUCTION DIAGRAM



ATTACHMENT 2

**MONITORING WELL DEVELOPMENT
SOP NO. 021**

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

MONITORING WELL DEVELOPMENT

SOP NO. 021

REVISION NO. 3

Last Reviewed: October 2000

K. Riesing

Quality Assurance Approved

October 5, 2000

Date

1.0 BACKGROUND

All drilling methods impair the ability of an aquifer to transmit water to a drilled hole. This impairment is typically a result of disturbance of soil grains (smearing) or the invasion of drilling fluids or solids into the aquifer during the drilling process. The impact to the hydrologic unit surrounding the borehole must be remediated so that the well hydraulics and samples collected from the monitoring well are representative of the aquifer.

Well development should be conducted as an integral step of monitoring well installation to remove the finer-grained material, typically clay and silt, from the geologic formation near the well screen and filter pack. (Monitoring well installation is discussed in standard operating procedure [SOP] No. 020.) The fine-grained particles may interfere with water quality analyses and alter the hydraulic characteristics of the filter pack and the hydraulic unit adjacent to the well screen. Well development improves the hydraulic connection between water in the well and water in the formation. The most common well development methods are surging, jetting, overpumping, and bailing.

The health and safety plan for the site should be followed to avoid exposure to chemicals of concern. Water, sediment, and other waste removed from a monitoring well should be disposed of in accordance with applicable federal, state, and local requirements.

1.1 PURPOSE

This SOP establishes the requirements and procedure for monitoring well development. Well development improves the hydraulic characteristics of the filter pack and borehole wall by performing the following functions:

- Reducing the compaction and the intermixing of grain sizes produced during drilling by removing fine material from the pore spaces.
- Removing the filter cake or drilling fluid film that coats the borehole as well as much or all of the drilling fluid and natural formation solids that have invaded the formation.
- Creating a graded zone of sediment around the screen, thereby stabilizing the formation so that the well can yield sediment-free water.

1.2 SCOPE

This SOP applies to the development of newly installed monitoring wells. The SOP identifies the most commonly used well development methods; these methods can be used individually or in combination to achieve the most effective well development. Selection of a particular method will depend on site conditions, equipment limitations, and other factors. The method selected and the rationale for selection should be documented in a field logbook or appropriate project reports.

1.3 DEFINITIONS

Aquifer: A geologic formation, group of formations, or part of a formation that is saturated and capable of storing and transmitting water.

Aquitard: a geologic formation, group of formations, or part of a formation through which virtually no water moves.

Bailer: A cylindrical sampling device with valves on either end, used to extract water from a well or borehole.

Bentonite seal: A colloidal (extremely fine particle that will not settle out of solution) clay seal separating the sand pack from the surface seal.

Drilling fluid: A fluid (liquid or gas) that may be used in drilling operations to remove cuttings from the borehole, to clean and cool the drill bit, and to maintain the integrity of the borehole during drilling.

Filter pack: A clean, uniform sand or gravel placed between the borehole wall and the well screen to prevent formation material from entering the screen.

Grout seal: A fluid mixture of (1) cement and water or (2) cement, bentonite, and water that is placed above the bentonite seal between the casing and the borehole wall to secure the casing in place and keep water from entering the borehole.

Hydraulic conductivity: A measure of the ease with which water moves through a geologic formation. Hydraulic conductivity, K, is typically measured in units of distance per time in the direction of groundwater flow.

Hydrologic units: Geologic strata that can be distinguished on the basis of capacity to yield and transmit fluids. Aquifers and confining units are types of hydrologic units.

Oil air filter: A filter or series of filters placed in the airflow line from an air compressor to reduce the oil content of the air.

Oil trap: A device used to remove oil from the compressed air discharged from an air compressor.

Riser: The pipe extending from the well screen to or above the ground surface.

Specific conductance: A measure of the ability of the water to conduct an electric current. Specific conductance is related to the total concentration of ionizable solids in the water and is inversely proportional to electrical resistance.

Static water level: The elevation of the top of a column of water in a monitoring well or piezometer that is not influenced by pumping or conditions related to well installation, hydrologic testing, or nearby pumpage.

Transmissivity: The volume of water transmitted per unit width of an aquifer over the entire thickness of the aquifer flow, under a unit hydraulic gradient.

Well screen: A cylindrical pipe with openings of a uniform width, orientation, and spacing used to keep materials other than water from entering the well and to stabilize the surrounding formation.

Well screen jetting (hydraulic jetting): A jetting method used for development; nozzles and a high pressure pump are used to force water outwardly through the screen, the filter pack, and sometimes into the adjacent geologic unit.

1.4 REFERENCES

- American Society for Testing and Materials. 1990. Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers. D5092-90. West Conshohocken, Pennsylvania.
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1.5 REQUIREMENTS AND RESOURCES

The type of equipment used for well development will depend on the well development method. Well development methods and the equipment required are discussed in Section 2.1 of this SOP. In general, monitoring wells should be developed shortly after they are installed but no sooner than 24 hours after the placement of the grout seal, depending on the grout cure rate and well development method. Most drilling or well development rigs have pumps, air compressors, bailers, surge blocks, and other equipment that can be used to develop a monitoring well.

All downhole equipment should be properly decontaminated before and after each well is developed. See SOP No. 002 (General Equipment Decontamination) for details.

2.0 WELL DEVELOPMENT PROCEDURES

This section describes common well development methods, factors to be considered in selecting a well development method, procedures for initiating well development, well development duration, and calculations typically made during well development. In addition to this, procedures described in any

work plans for well development should be fully consistent with local and state regulations and guidelines.

2.1 WELL DEVELOPMENT METHODS

Well development methods vary with the physical characterization of hydrologic units in which the monitoring well is screened and the drilling method used. The most common methods include mechanical surging, overpumping, air lift pumping, backwashing, surge bailing, and well jetting. These methods may be effective alone or may need to be combined (for example, overpumping combined with backwashing). Factors such as well design and hydrogeologic conditions will determine which well development method will be most practical and cost-effective. Commonly used well development methods are described in Sections 2.1.1 through 2.1.6.

The use of chemicals for monitoring well development should be avoided as much as possible. Introduction of chemicals may significantly alter groundwater chemistry in and around the well.

2.1.1 Mechanical Surging

The mechanical surging method forces water to flow in and out of the well screen by operating a plunger (or surge block) in the casing, similar to a piston in a cylinder. A typical surge block is shown in Figure 1. The surge block should fit snugly in the well casing to increase the surging action. The surge block is attached to a drill rod or drill stem and is of sufficient weight to cause the block to drop rapidly on the down stroke, forcing water contained in the borehole into the aquifer surrounding the well. In the recovery stroke or upstroke, water is lifted by the surge block, allowing water and fine sediments to flow back into the well from the aquifer. Down strokes and recovery strokes are usually 3 to 5 feet in length.

The surge block should be lowered into the water column above the well screen. The water column will effectively transmit the action of the block to the filter pack and hydrologic unit adjacent to the well screen. Development should begin above the screen and move progressively downward to prevent the surge block from becoming sand locked in the well. The initial surging action should be relatively gentle, allowing any material blocking the screen to break up, go into suspension, and then move into the well. As water begins to move easily both in and out of the screen, the surge block is usually lowered in

increments to a level just above the screen. As the block is lowered, the force of the surging movement should be increased. In wells equipped with long screens, it may be more effective to operate the surge block in the screen to concentrate its actions at various levels.

A pump or bailer should be used periodically to remove dislodged sediment that may have accumulated at the bottom of the well during the surging process. The pump or bailer should be moved up and down at the bottom of the well to suspend and collect as much sediment as possible.

The accumulation of material developed from a specific screen interval can be measured by sounding the total depth of the well before and after surging. Continue surging until little or no sand accumulates.

2.1.2 Overpumping

Overpumping involves pumping the well at a rate substantially higher than it will be pumped during well purging and groundwater sampling. This method is most effective on coarse-grained formations and is usually conducted in conjunction with mechanical surging or backwashing. Overpumping is commonly implemented using a submersible pump. In cases where the water table is less than 30 feet from the top of the casing, it is possible to overpump the well with a centrifugal pump. The intake pipe is lowered into the water column at a depth sufficient to ensure that the water in the well is not drawn down to the pump intake level. The inflow of water at the well screen is not dependent on the location of the pump intake as long as it remains submerged.

Overpumping will induce a high velocity water flow, resulting in the flow of sand, silt, and clay into the well, opening clogged screen slots and cleaning formation voids and fractures. The movement of these particles at high flow rates should eliminate particle movement at the lower flow rates used during well purging and sampling. The bridging of particles against the screen because of the flow rate and direction created by overpumping may be overcome by using mechanical surging or backwashing in conjunction with this method.

2.1.3 Air Lift Pumping

Air lift pumping uses a two-pipe system consisting of an air injection pipe and a discharge pipe. In this well development method, an air lift pump is operated by cycling the air pressure on and off for short periods of time. This operation provides a surging action that can dislodge fine-grained particles in the vicinity of the well screen. Subsequently applying a steady low pressure removes the fines drawn into the well by the surging action.

The bottom of the air lift should be at least 10 feet above the top of the well screen. Air is injected through an inner pipe at sufficient pressure to bubble out directly into the surrounding discharge pipe. The bubbles formed by the injected air cause the column of water in the discharge pipe to be lifted upward and allow water from the aquifer to flow into the well. This arrangement prevents injected air from entering the well screen. Pumping air through the well screen and into the filter pack and adjacent hydrologic unit should be avoided because it can cause air entrainment, inhibiting future sampling efforts and possibly altering groundwater chemistry.

The air injected into the well should be filtered using an oil/air filter and oil trap to remove any compressor lubricant entrained in the air. Air pressures required for this well development method are relatively low; an air pressure of 14.8 pounds per square inch should move a 30-foot column of water. For small-diameter, shallow wells where the amount of development water is likely to be limited, tanks of inert gas (such as nitrogen) can be used as an alternative to compressed air.

2.1.4 Backwashing

Effective development procedures should cause flow reversals through the screen openings that will agitate the sediment, remove the finer fraction, and then rearrange the remaining formation particles. Backwashing overcomes the bridging that results from overpumping by allowing the water that is pumped to the top of the well to flow back through the submersible pump and out through the well screen. The backflow portion of the backwashing cycle breaks down bridging, and the inflow then moves the fine material toward the screen and into the well.

Some wells respond satisfactorily to backwashing techniques, but the surging effect is not vigorous enough to obtain maximum results in many cases.

A variation of backwashing may be effective in low-permeability formations. After the filter pack is installed on a monitoring well, clean water is circulated down the well casing, out through the well screen and filter pack, and up through the open borehole before the grout or bentonite seal is placed in the annulus. Flow rates should be controlled to prevent floating the filter pack. Because of the low hydraulic conductivity of the formation, negligible amounts of water will infiltrate into the formation. Immediately after this procedure, the bentonite seal should be installed, and the nonformation water should be pumped out of the well and filter pack.

2.1.5 Surge Bailing

Surge bailing can be an effective well development method in relatively clean, permeable formations where water flows freely into the borehole. A bailer made of stainless steel or polyvinyl chloride and slightly smaller than the well casing diameter is allowed to fall freely through the borehole until it strikes the groundwater surface. The contact of the bailer produces a downward force and causes water to flow outward through the well screen, breaking up bridging that has developed around the screen. As the bailer fills and is rapidly withdrawn from the well, the drawdown created causes fine particles to flow through the well screen and into the well. Subsequent bailing can remove these particles from the well. Lowering the bailer to the bottom of the well and using rapid short strokes to agitate and suspend solids that have settled to the well bottom can enhance removal of sand and fine particles. Bailing should continue until the water is free of suspended particles.

2.1.6 Well Jetting

Well jetting can be used to develop monitoring wells in both unconsolidated and consolidated formations. Water jetting can open fractures and remove drilling mud that has penetrated the aquifer. The discharge force of the jetting tool is concentrated over a small area of the well screen. As a result, the tool must be rotated constantly while it is raised and lowered in a very small increments to be sure that all portions of the screen are exposed to the jetting action.

Jetting is relatively ineffective on the fine screens typically used in monitoring wells (slot sizes from 0.01 to 0.02 inch). In addition, jetting requires the introduction of external water into the well and surrounding formation. This water should be obtained from a source of known chemistry. Water introduced for development should be completely removed from the aquifer immediately after development.

The use of compressed air as a jetting agent should not be employed for development of monitoring wells. Compressed air could entrain air in the formation, introduce oil into the formation, and damage the well screen.

2.2 FACTORS TO CONSIDER WHEN SELECTING A WELL DEVELOPMENT METHOD

It is important to check federal, state, and local regulatory requirements for monitoring well development requirements. This SOP may be changed to accommodate applicable regulations, site conditions, or equipment limitations.

The type of geologic material, the design and completion of the well, and the type of drilling method used are all factors to be considered during the development of a monitoring well.

Monitoring well development should usually be started slowly and gently and then performed with increasing vigor as the well is developed. Most well development methods require the application of sufficient energy to disturb the filter pack, thereby freeing fine particles and allowing them to be drawn into the well. The coarser particles then settle around and stabilize the screen.

Development procedures for wells completed in fine sand and silt strata should involve methods that are relatively gentle so that strata material will not be incorporated into the filter pack. Vigorous surging for development can produce mixing of the fine strata and filter pack and produce turbid samples from the formation. In addition, development methods should be carefully selected based upon the potential contaminants present, the quantity of wastewater generated, and requirements for containerization or treatment of wastewater.

For small diameter and small volume wells, a development bailer can be used in place of a submersible pump in the pumping method. Similarly, a bailer can be used in much the same fashion as a surge block in small diameter wells.

Any time an air compressor is used for well development, it should be equipped with an oil air filter or oil trap to minimize the introduction of oil into the screened area. The presence of oil could impact the organic constituent concentrations of the water samples collected from the well.

The presence of light nonaqueous phase liquid (LNAPL) can impact monitoring well development. Water jetting or vacuum-enhanced well development may assist in breaking down the smear zone in the LNAPL. Normal development procedures are conducted in the water-saturated zone and do not affect the LNAPL zone.

2.3 INITIATING WELL DEVELOPMENT

Newly completed monitoring wells should be developed as soon as practical, but no sooner than 24 hours after grouting is completed if rigorous well development methods are used. Development may be initiated shortly after well installation if the development method does not interfere with the grout seal. State and local regulations should be checked for guidance. The following general well development steps can be used with any of the methods described in Section 2.1.

1. Assemble the necessary equipment on a plastic sheet around the well. This may include a water level meter (or oil/water interface probe if LNAPL or dense nonaqueous phase liquid is present); personal protective equipment; pH, conductivity, temperature, and turbidity meters; air monitoring equipment; Well Development Data Sheets (see Figure 2); a watch; and a field logbook.
2. Open the well and take air monitoring readings at the top of the well casing and in the breathing zone. See SOP No. 003 (Organic Vapor Air Monitoring) for additional guidance.
3. Measure the depth to water and the total depth of the monitoring well. See SOP No. 014 (Static Water Level, Total Well Depth, and Immiscible Layer Measurement) for additional guidance.
4. Measure the initial pH, temperature, turbidity, and specific conductance of the groundwater from the first groundwater that comes out of the well. Note the time, initial

color, clarity, and odor of the water. Record the results on a Well Development Data Sheet (see Figure 2) or in a field logbook. See SOPs No. 011 (Field Measurement of Water Temperature), 012 (Field Measurement of pH), 013 (Field Measurement of Specific Conductance), and 088 (Field Measurement of Water Turbidity) for additional guidance.

5. Develop the well using one or more of the methods described in Section 2.1 until the well is free of sediments and the groundwater turbidity has reached acceptable levels. Record the development method and other pertinent information on a Well Development Data Sheet (see Figure 2) or in a field logbook.
6. Containerize any groundwater produced during well development if groundwater contamination is suspected. The containerized water should be sampled and analyzed to determine an appropriate disposal method.
7. Do not add water to assist in well development unless the water is from a source of known chemical quality and the addition has been approved by the project manager. If water is added, five times the amount of water introduced should be removed during development.
8. Continue to develop the well, repeating the water quality measurements for each borehole volume. Development should continue until each water quality parameter is stable to within 10 percent. Development should also continue until all the water added during development (if any) is removed or the water has a turbidity of less than 50 nephelometric turbidity units. This level may only be attainable after allowing the well to settle and testing at low flow sampling rates.
9. At the completion of well development, measure the final pH, temperature, turbidity, and specific conductance of the groundwater. Note the color, clarity, and odor of the water. Record the results on a Well Development Data Sheet (see Figure 2) or in a field logbook. In addition to the final water quality parameters, the following data should be noted on the Well Development Data Sheet: well identification, date(s) of well installation, date(s) and time of well development, static water level before and after development, quantity of water removed and time of removal, type and capacity of pump or bailer used, and well development technique.

All contaminated water produced during development should be containerized in drums or storage vessels properly labeled with the date collected, generating address, well identification, and consultant contact number.

2.4 DURATION OF WELL DEVELOPMENT

Well development should continue until representative water, free of the drilling fluids, cuttings, or other materials introduced during well construction is obtained. When pH, temperature, turbidity, and specific conductance readings stabilize and the water is visually clear of suspended solids, the water is representative of formation water. The minimum duration of well development should vary in accordance with the method used to develop the well. For example, surging and pumping the well may provide a stable, sediment free sample in a matter of minutes, whereas bailing the well may require several hours of continuous effort to obtain a clear sample.

An on-site project geologist should make the final decision as to whether well development is complete. This decision should be documented on a Well Development Data Sheet (see Figure 2) or in a field logbook.

2.5 CALCULATIONS

It is necessary to calculate the volume of water in the well. Monitoring well diameters are typically 2, 3, 4, or 6 inches. The height of water column (in feet) in the well can be multiplied by the following conversion factors to calculate the volume of water in the well casing.

Well Diameter (inches)	Volume (gallon per foot)
2	0.1631
3	0.3670
4	0.6524
6	1.4680

3.0 POTENTIAL PROBLEMS

The following potential problems can occur during development of monitoring wells:

- In some wells the pH, temperature, and specific conductance may stabilize but the water remains turbid. When this occurs, the well may still contain construction materials (such as drilling mud in the form of a mud cake) and formation soils that have not been washed out of the borehole. Excessive or thick drilling muds cannot be flushed out of a borehole with one or two well volumes of flushing. Continuous flushing over a period of several days may be necessary to complete well development. If the well is completed in a silty zone, it may be necessary to sample with low flow methods or filtering.
- Mechanical surging and well jetting disturb the formation and filter pack more than other well development methods. In formations with high clay and silt contents, surging and jetting can cause the well screen to become clogged with fines. If an excessive amount of fines is produced, sand locking of the surge block may result. Well development with these methods should be initiated gently to minimize disturbance of the filter pack and to prevent damage to the well screen.
- Effective overpumping may involve the discharge of large amounts of groundwater. This method is not recommended when groundwater extracted during well development is contaminated with hazardous constituents. If the hazardous constituents are organic compounds, this problem can be partially overcome by passing the groundwater through an activated carbon filter.
- When a well is developed by mechanical surging or bailing, rapid withdrawal of the surge block or bailer can result in a large external pressure outside of the well. If the withdrawal is too rapid and this pressure is too great, the well casing or screen can collapse.
- A major disadvantage of well jetting is that an external supply of water is needed. The water added during well jetting may alter the hydrochemistry of the aquifer; therefore, the water added in this development procedure should be obtained from a source of known chemistry. In addition, the amount of water added during well development and the amount lost to the formation should be recorded.
- The use of air in well development can chemically alter the groundwater, either directly through chemical reaction or indirectly as a result of impurities introduced through the air stream. In addition, air entrainment within the formation can interfere with the flow of groundwater into the monitoring well. Consequently, air should not be injected in the immediate vicinity of the well screen.

FIGURE 1
SCHEMATIC DRAWING OF A SURGE BLOCK

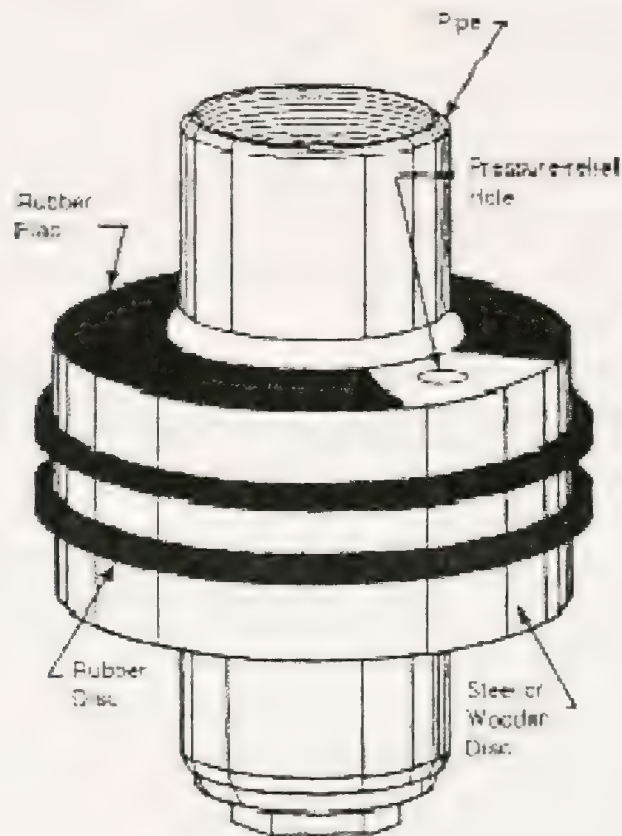


FIGURE 2
WELL DEVELOPMENT DATA SHEET

WELL DEVELOPMENT DATA SHEET							
BORING NO. _____				WELL NO. _____			
Project _____				Casing Diameter/Type _____			
Project No. _____				Borehole Diameter _____			
Date(s) of Installation _____				Screened Interval(s) _____			
Date(s) of Development _____				Total Length of Well Casing _____			
Personnel/Company _____				Measured Total Depth (TOC) Initial _____ Final _____			
Type of Rig Used _____				Initial Depth to Water _____ (TOC) _____ Date _____ Time _____			
				Stabilized Depth to Water _____ (TOC) _____ Date _____ Time _____			
<u>DEVELOPMENT</u>		<u>EQUIPMENT TYPE/CAPACITY</u>		<u>PURGE VOLUME CALCULATION</u>			
<u>TECHNIQUE(S)</u>							
Surging _____		_____		Casing Volume: _____ Ft. of water			
Overpumping _____		_____		x _____ Gallons/Foot			
Air Lift Pumping _____		_____		= _____ Gallons per Single Casing Volume			
Backwashing _____		_____		Sand Pack Volume _____ Ft. of Saturated Sand Pack			
Bailing _____		_____		x _____ Gallons/Foot (borehole diameter)			
Well Jetting _____		_____		= _____ Gallons (in borehole)			
				= _____ Gallons of Casing Volume			
				= _____ x 0.3 (Assuming porosity = 30%)			
				= _____ Gallons Within Sand Pack			
<u>FLUIDS ADDED</u>				Single Purge Volume: _____ Gallons (Casing Vol. + Sand Pack Vol. + Fluids Added)			
Lost Drilling Fluid: _____ Gallons				Minimum Purge Volume: _____ Gallons			
Lost Purge Water: _____ Gallons				Actual Purge Volume: _____ Gallons			
Water During Installation _____ Gallons				Volume Measured by _____			
Total Fluids Added _____ Gallons				Rate of Development _____ Gallons/Minute (Hour, Day)			
Source of Added Water _____				Pumping Rate/Depth _____ @ _____ Ft. (Below Grd.)			
Sample Collected of Added Water _____ Y _____ N				Immiscible Phases Present: Y N Thickness _____			
Sample Designation of Added Water: _____							
Development Criteria: _____							
Total Volume Discharged	Rate of Discharge	Time	Temp	pH	Specific Conductance	Turbidity (NTU)	D.O., Clarity, Odor, PID Readings, Other
Development Completed at _____ Gallons Discharged Date _____ Time _____							
Personnel _____							

* Specific Conductance readings temperature compensated to 25 °C, if not, report temperatures at which reading obtained							

ATTACHMENT 3

**GROUNDWATER SAMPLING
SOP NO. 010**

SOP APPROVAL FORM

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

GROUNDWATER SAMPLING

SOP NO. 010

REVISION NO. 3

Last Reviewed: March 2000

R. Riesing

Quality Assurance Approved

February 19, 1993

Date

1.0 BACKGROUND

Groundwater sampling may be required for a variety of reasons, such as examining potable or industrial water supplies, checking for and tracking contaminant plume movement in the vicinity of a land disposal or spill site, Resource Conservation and Recovery Act (RCRA) compliance monitoring, or examining a site where historical information is minimal or non-existent, but where groundwater may be contaminated.

Groundwater is usually sampled through an in-place well, either temporarily or permanently installed. However, it can also be sampled anywhere groundwater is present, such as a pit or a dug or drilled hole.

Occasionally, a well will not be in the preferred location to obtain the sample needed (for example, to track a contaminant plume). In such a case, a temporary or permanent well will have to be installed. An experienced and knowledgeable person, preferably a hydrogeologist, will need to locate the well and supervise its installation so that the samples ultimately collected will be representative of the groundwater. SOP No. 020 (Monitoring Well Installation) provides guidance for installing new monitoring wells.

1.1 PURPOSE

This standard operating procedure (SOP) establishes the requirements and procedures for determining the quality of groundwater entering, leaving, or affected by site activities through groundwater sampling. The samples are obtained by retrieving water from a well screened in the aquifer(s) underlying a site.

1.2 SCOPE

This SOP provides general guidance for groundwater sampling activities conducted in the field. SOP No. 015 (Groundwater Sample Collection Using Micropurge Technology) provides additional specific guidance for using low flow methods to collect groundwater samples.

1.3 DEFINITIONS

Bailer: A cylindrical sampling device with valves on either end used to extract water from a well. Bailers are usually constructed of an inert material such as stainless steel or polytetrafluoroethylene (Teflon). The bailer is lowered and raised by means of a cable that may be cleaned and reused, or by disposable rope.

Electrical Water Level Indicator: An electrical device that has a light or sound alarm connected to an open circuit used to determine the depth to liquid. The circuit is closed when the probe intersects a conducting liquid. The wire used to raise and lower the probe is usually graduated.

Immiscible Phase: Liquid phases that cannot be uniformly mixed or blended with water. Heavy immiscible phases sink, and light immiscible phases float on water.

Interface Probe: An electrical probe that determines the distance from the surface to air/water, air/immiscible, or immiscible/water interfaces.

Purge Volume: The volume of water that needs to be removed from the well prior to sampling to ensure that the sample collected is representative of the groundwater.

Riser Pipe: The length of well casing above the ground surface.

Total Well Depth: The distance from the ground surface to the bottom of the well.

Water Level: The level of water in a well, measured as depth to water or as elevation of water, relative to a reference mark or datum.

1.4 REFERENCES

U.S. Department of Energy. 1985. "Procedures for the Collection and Preservation of Groundwater and Surface Water Samples and for the Installation of Monitoring Wells: Second Edition." Edited by N. Korte and P. Kearl. Technical Measurements Center, Grand Junction Projects Office. GJ/TMC-08.

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- EPA. 1984. "Sampling at Hazardous Materials Incidents." EPA Hazardous Response Support Division, Cincinnati, 1984.
- EPA. 1995. "Groundwater Well Sampling." Environmental Response Team SOP #2007 (Rev. #0.0, 01/26/95). On-Line Address: http://204.46.140.12/media_resrcs/media_resrcs.asp?Child1=
- U.S. Geological Survey. 1984. "National Handbook of Recommended Methods for Water-Data Acquisition" Reston, Virginia.

1.5 REQUIREMENTS AND RESOURCES

There are various options available to obtain groundwater samples. The procedures are outlined in the following section. The equipment needed to accomplish these procedures includes the following:

- Organic vapor detector with a flame ionization detector (FID) or a photoionization detector (PID)
- Pipe wrench
- Electrical water level indicator or interface probe
- Steel tape with heavy weight
- Purging device (type needed depends on well depth, casing diameter, and type of sample desired; see sampling devices below)
- Sampling device (type needed depends upon depth to water and type of sample desired)
 - Teflon bailer
 - Stainless steel bailer
 - Teflon bladder pump
 - Stainless steel submersible (nonoil-bearing) pump
 - Existing dedicated equipment
 - Peristaltic pump
- Sample containers
- Wastewater containers
- Field logbook
- Stopwatch

Additional equipment is required to complete measurement of field parameters (for example, pH, specific conductance, and temperature) of the groundwater in the well.

2.0 PROCEDURE

Prior to sampling, a site-specific sampling plan should be developed. The plan should take into consideration the site characteristics and should include:

- Specific repeatable well measurement techniques and reference points for determining the depth to water and the depth to the bottom of the well
- Specific method of purging and selection of purging equipment
- Specific methods and equipment for measurements of field parameters
- Specific method of sample collection and the sampling equipment that will be used
- Specific parameters for which samples will be analyzed
- Order in which sample bottles will be filled, based on the analytical parameters

The following sections discuss procedures for approaching the well, establishing a sample preparation area, making preliminary well measurements, purging the well, and collecting samples.

2.1 APPROACHING THE WELL

In general, all wells should be assumed to pose a health and safety risk until field measurements indicate otherwise. Approach wells from the upwind side. Record well appearance and general condition of the protective casing, surface seal, and surrounding area in the logbook.

Once at the well, the lead person should systematically use the organic vapor detector to survey the immediate area around the well (from the breathing zone to the top of the casing to the ground). If elevated FID and PID meter readings are encountered, retreat to a safe area and instruct the sampling team to put on the appropriate level of personal protective equipment (PPE). See SOP No. 003 (Organic Vapor Air Monitoring) for additional guidance.

Upon opening the well casing, the lead person should systematically survey inside the well casing, above the well casing in the breathing zone and the immediate area around the well. If elevated FID or PID meter readings in the breathing zone are encountered (see health and safety plan for action levels), retreat and put on appropriate PPE. It is important to remember that action levels are based on readings in the breathing zone, not within the well casing. Representative organic vapor detector readings should be recorded in the logbook.

2.2 ESTABLISHING A SAMPLE PREPARATION AREA

The sample preparation area is generally located upwind or to either side of the well. If elevated readings are encountered using an organic vapor detector, this area should be taped off and the sample preparation area should be located upwind where ambient readings are found.

2.3 MAKING PRELIMINARY WELL MEASUREMENTS

Several preliminary well measurements should be made prior to initiating sampling of the well. These include determining water level and total well depth measurements, determining the presence of immiscible phases, and calculating purge volumes. All preliminary measurements will be recorded in the logbook as they are determined. SOP No. 014 (Static Water Level, Total Well Depth, and Immiscible Layer Measurement) provides additional information concerning these preliminary measurements.

2.3.1 Water Level and Total Well Depth Measurements

Tetra Tech typically uses an electric water level indicator for water level measurements. This device sounds an alarm or illuminates a light when the measuring probe touches the water surface, thus closing an electrical circuit. The electric cable supporting the probe is usually graduated in feet and can be read at the well site directly. The remaining fraction is measured with a steel tape graduated to 0.01 foot. The distance between the static water level and the marked or notched location at the top of the riser pipe is measured. The height of the riser pipe above ground surface, as obtained from well location survey data, is then subtracted from the total reading to give the depth to static water. To improve accuracy, three separate readings should be made, and the values averaged. This helps to eliminate any errors due to kinks or bends in the cables, which may change in length when the water level indicator is raised and lowered.

The total well depth can be measured by using a steel tape with a heavy weight attached to the end. The tape is lowered into the well until resistance is met, indicating that the weight has reached the bottom of the well. The total well depth is then read directly from the steel tape to the 0.01-foot fraction. The distance between the bottom of the well and the marked or notched location on the riser pipe is measured. The height of the riser pipe above the ground surface, as obtained from well survey data, is then subtracted from the total reading to give the depth to the bottom of the well. To improve accuracy, three separate readings should be made, and the readings averaged.

2.3.2 Determining If Immiscible Phases Are Present

If immiscible phases (organic floaters or sinkers) are present, the following measurement activities should be undertaken. Organic liquids are measured by lowering an interface probe slowly to the surface of the liquid in the well. When the audible alarm sounds, record the depth. If the alarm is continuous, a floating immiscible layer has been detected. To determine the thickness of this layer, continue lowering the probe until the alarm changes to an oscillating signal. The oscillating signal indicates that the probe has detected an aqueous layer. Record this depth as the depth to water and determine the thickness and the volume of the immiscible layer.

Continue lowering the probe into the well to determine if dense immiscible phases (sinkers) are present. If the alarm signal changes from oscillating to a continuous sound, a heavier immiscible layer has been detected; record this depth.

Continue lowering the probe to the bottom of the well and record the total depth. Separate total depth measurements with a steel tape are not necessary when using an interface probe. Calculate and record the sinker phase volume and total water volume in the well. A chart is provided in Table 1 to assist in these calculations. If immiscible phases are present, immediately refer to Section 2.5.3 or 2.5.4 of this SOP.

2.3.3 Determination of Purging Volume

If the presence of floaters or sinkers does not need to be determined, determine the depth to water and the total depth of the well as described in Section 2.3.1. Once these measurements have been made and recorded, use Table 1 to calculate the total volume of water in the well. Multiply this volume by the purging factor to determine purging volume. The minimum purging factor is typically three casing

volumes but may be superseded by site-specific program requirements, individual well yield characteristics, or stabilization of field parameters measured during purging. Field parameters (for example, pH, specific conductance, and temperature) should be measured prior to purging and after each well volume. All field parameter data should be recorded in the field logbook. SOPs No. 011 (Field Measurement of Water Temperature), 012 (Field Measurement of pH), and 013 (Field Measurement of Specific Conductance) include more detailed procedures for determining these field parameters.

In Table 1, the volume of water in a 1-foot section of a 2-inch-diameter well is 0.163 gallon. This chart can easily be used for any water depth by multiplying all the values in Table 1 by the L value (depth, in feet, of water in the well). The volume of water in the well is based on the following formula:

$$V = \frac{\pi \times D^2}{4} \times L$$

where

- V = volume of water in the well (cubic feet)
D = inside diameter of the well (feet)
L = depth of water in the well (feet)

2.4 PURGING THE WELL

Currently, Tetra Tech standards allow for six options for purging wells:

1. Teflon bailers
2. Stainless steel bailers
3. Teflon bladder pumps
4. Stainless steel submersible (nonoil-bearing) pumps
5. Existing dedicated equipment
6. Peristaltic pumps (these devices are for shallow wells only)

As previously stated, the minimum purging volume is typically three casing volumes. Exceptions to this standard may be made in the case of low-yield wells. When purging low-yield wells, purge the well once

to dryness. Samples should be collected as soon as the well recovers. When the time required for full recovery exceeds 3 hours, samples should be collected as soon as sufficient groundwater volume is available.

The well should be purged until measured field parameters have stabilized. If any field parameter has not stabilized, additional purging should be performed. To be considered stable, field parameters should change by no more than the tolerance levels listed on Table 2 between each well volume purged.

At no time should the purging rate be high enough to cause the groundwater to cascade back into the well, resulting in excessive aeration and potential stripping of volatile constituents.

The actual volume of purged water can be measured using several acceptable methods:

- When bailers are used, the actual volume of each bailer's contents can be measured using a calibrated bucket.
- If a pump is used for purging, the pump rate can be determined by using a bucket of known volume, stopwatch, and the duration of pumping time necessary to purge the known volume.

2.5 SAMPLE COLLECTION

This section first describes general groundwater sample collection procedures. This section also describes procedures for collecting groundwater samples for volatile organic analysis (VOA) and for collecting samples when light or heavy immiscible layers are present in a monitoring well. Samples of light and heavy immiscible layers should be collected before the well is purged.

2.5.1 General Groundwater Sampling Procedures

The technique used to withdraw a groundwater sample from a well should be selected based on the parameters for which the sample will be analyzed. To ensure that the groundwater samples are representative, it is important to avoid physically altering or chemically contaminating the sample during collection, withdrawal, or containerization. If the samples are to be analyzed for volatile organic compounds, it is critical that air does not become entrained in the water column.

Acceptable sampling devices for all parameters are double check valve stainless steel or Teflon bailers, bladder pumps, low-flow positive displacement pumps, or for shallow wells, peristaltic pumps. Additional measurements of field parameters should be performed at the time of sampling.

In some cases, it may become necessary to use dedicated equipment already in the well to collect samples. This is particularly true of high volume, deep wells (>150 feet) where bladder pumps are ineffective and bailing is impractical. If existing equipment must be used, however, determine the make and model of the pump and obtain information on component construction materials from the manufacturer or facility representatives. If an existing pump is to be used for sampling, make sure the flow volume can be reduced so that a reliable VOA sample can be taken. Record the specific port, tap, or valve from which the sample is collected.

General sampling procedures include the following:

- Clean sampling equipment should not be placed directly on the ground. Use a plastic drop cloth or feed line from clean reels. Never place contaminated lines back on reels.
- Check the operation of the bailer check valve assemblies to confirm free operation.
- If the bailer cable is to be decontaminated and reused, it must be made of Teflon-coated stainless steel.
- Lower sampling equipment slowly into the well to avoid degassing the water and damaging the equipment.
- Pump flow rates should be adjusted to eliminate intermittent or pulsed flow. The settings should be determined during the purging operations.
- A separate sample volume should be collected to measure necessary field parameters. Samples should be collected and containerized in the order of the parameters' volatilization sensitivity. Table 3 lists the preferred collection order for common groundwater parameters.

Intermediate containers should never be used to prepare VOA samples and should be avoided for all parameters in general. All VOA containers should be filled at a single sampling point or from a single bailer volume.

2.5.2 Collection of Volatile Organics Samples

This section discusses the collection of samples for VOA using either a bailer or bladder pump in detail. Other pumps (such as positive displacement or peristaltic) can be used. The following factors are critical to the collection of representative samples for VOA: ensuring that no air has become entrained in the water column, low pump flow rates (less than 100 milliliter [mL] per minute, if possible), and avoiding flow surges.

2.5.2.1 Collection with Bailers

Samples for VOA should be collected from the first bailer removed from the well after purging. The most effective means requires two people. One person should retrieve the bailer from the well and pour its contents into the appropriate number of 40-mL VOA vials held by the second person. Cap each vial and invert it. If a bubble exists, unscrew the cap and add more water, or discard and repeat. The sample should be transferred from the bailer to the sample container in a manner that will limit the amount of agitation in order to reduce the loss of volatile organics from the sample.

Always fill VOA vials from a single bailer volume. If the bailer is refilled, samples cannot be considered duplicates or splits.

2.5.2.2 Collection with a Bladder Pump (Well Wizard)

To successfully perform VOA sampling with a Well Wizard bladder pump, the following steps must be completed:

1. Following manufacturer's directions, activate the pump. Full water flow from the discharge tubing will begin after 5 to 15 pumping cycles. These initial pumping cycles are required to purge air from the pump and discharge tubing. The discharge and recharge settings must be manually set and adjusted to pump at optimum flow rates. To activate the bladder, it is best to set the initial cycle at long discharge and recharge rates.
2. Reduce water flow rate for VOA sample collection. To reduce the water flow rate, turn the throttle control valve (located on the left side of the Well Wizard pump control panel) counterclockwise.

3. Collect VOA sample from discharge tubing. VOA vials must be placed beneath the discharge tubing while avoiding direct contact between the vials and the tubing. Never place tubing past the mouth of the VOA vial. The pump throttle control must be turned as necessary to maintain a trickle of water in order to obtain a meniscus in the vial.
4. Continue with non-VOA sampling. Increase pump flow rate by turning the throttle control knob clockwise.

2.5.3 Collection of Light Immiscible Floaters

The approach used when collecting floaters depends on the depth to the floating layer and the thickness of that layer. If the thickness of the floater is 2 feet or greater, a bottom-filling valve bailer should be used. Slowly lower the bailer until contact is made with the floater surface, and lower the bailer to a depth less than that of the floater/water interface depth as determined by preliminary measurements with the interface probe.

When the thickness of the floating layer is less than 2 feet, and the depth to the surface of the floating layer is less than 15 feet, a peristaltic pump can be used to extract a sample.

When the thickness of the floating layer, however, is less than 2 feet and the depth to the surface of the floating layer is beyond the effective "lift" of a peristaltic pump (greater than 25 feet), a bailer can be modified to allow filling from the top only (an acceptable alternative is to use a top-loading Teflon or stainless-steel bailer). Disassemble the bailer's bottom check valve and insert a piece of 2-inch diameter Teflon sheet between the ball and ball seat. This will seal off the bottom valve. Remove the ball from the top check valve, thus allowing the sample to enter from the top. To overcome buoyancy when the bailer is lowered into the floater, place a length of one-inch stainless steel pipe on the retrieval line above the bailer (this pipe may have to be notched to allow sample entry if the pipe remains within the top of the bailer). As an alternative, use a top-loading stainless-steel bailer. Lower the device, carefully measuring the depth to the surface of the floating layer, until the top of the bailer is level with the top of the floating layer. Lower the bailer an additional one-half thickness of the floating layer and collect the sample. This technique is the most effective method of collection if the floating layer is only a few inches thick.

2.5.4 Collection of Heavy Immiscible Sinkers

The best method for collection of sinkers is use of a double check valve bailer. The key to collection is controlled, slow lowering and raising of the bailer to and from the bottom of the well. Collection methods are equivalent to those described in Section 2.5.3 above.

TABLE 1
LIQUID VOLUME IN A 1-FOOT SECTION OF WELL CASING

Well Casing Inside Diameter (D) (inches)	Volume of Liquid in 1-Foot Well Section (gallons)
	$V = 0.0408 (D^2)$
1	0.041
1.5	0.092
2	0.163
3	0.367
4	0.653

TABLE 2
FIELD MEASUREMENT TOLERANCE LEVELS

Field Parameter	Tolerance Level
pH	0.1 pH unit
Specific Conductance	10 percent relative percent difference (RPD) ^a
Temperature	1 °C

Note:

^a RPD can be determined as follows:

$$RPD = \frac{(\text{Measurement 1} - \text{Measurement 2}) \times 100}{(\text{Measurement 1} + \text{Measurement 2}) / 2}$$

TABLE 3
ORDER OF PREFERRED SAMPLE COLLECTION

1. VOA
2. Purgeable organic halogens (POX)
3. Total organic halogens (TOX)
4. Cyanide
5. Extractable organics
6. Purgeable organic carbon (POC)
7. Total metals
8. Dissolved metals
9. Total organic carbon (TOC)
10. Phenols
11. Sulfate and chloride
12. Nitrate and ammonia
13. Radionuclides

5.0 RECLAMATION INVESTIGATION

The Montana Department of Environmental Quality-Mine Waste Cleanup Bureau (DEQ/MWCB) has requested that Tetra Tech EM Inc. conduct a reclamation investigation (RI) for the Spring Meadow Lake site. The RI delineates the nature and extent of mine wastes at the site, estimates risks these wastes may pose to human health and the environment, and presents data pertinent to potential reclamation. The RI field activities were described in Section 4, which was provided earlier under separate cover. This Section 5 will ultimately be part of a complete RI and expanded engineering evaluation and cost analysis (EEE/CA) report that will be compiled when this task order is complete.

5.1 INTRODUCTION

The first industrial use of the Spring Meadow Lake site dates to 1892, when the Stedman Foundry and Manufacturing Company opened a foundry. Workers erected three stone buildings to house the complex and a variety of iron products were produced, presumably for local use. The business closed because of insufficient funds in 1901. The Western Improved Wire Fence Company of the United States of America was the next site occupant, in 1906, but its tenure was also short lived and it abandoned the site by 1910.

The Northwestern Metals Company acquired the Stedman Foundry property in 1910 and installed a mill to process ore from its Comet, Bullion, and Crystal mine group in the Cataract Creek drainage basin south of Wickes, Montana. The 100-ton capacity mill employed the Baker-Burwell process, which used chlorine gas to react with the metals in the ore (dry chlorination) to convert the metals into metallic chlorides. The process was reported to work well on ores with high zinc content. Because of processing inefficiencies, however, the operation went into bankruptcy in 1915.

The New York – Montana Testing and Engineering Company formed in about 1916 and took over the Stedman Foundry property. With both testing and milling equipment, the company handled gold-silver and manganese ores. It received manganese shipments from the Ophir Mine in Butte and unnamed mines in Philipsburg, as well as material from the Valley Forge dumps near Rimini and possibly the Liverpool Mine in the Clancy district. An estimated 13,500 tons of manganese ore from Butte and Philipsburg plus 9,000 tons of local sulphide ore were probably processed at the Spring Meadow Lake site (RTI 2005). In 1918, New York-Montana Testing and Engineering acquired the 40-acre parcel north of the Foundry property from the Great Northern Railway. Although this information was not confirmed, the need for additional land for its tailings dump likely prompted the purchase (RTI 2005). Tailings from the

concentrator were dumped nearby, flushed with water, and allowed to flow across the ground, and may have encroached into the area (RTI 2005). This endeavor also was unsuccessful in the long term and closed in 1920.

The facility presumably stood vacant for several years until 1928, when George F. Jacoby acquired the foundry property (RTI 2005). Jacoby and his partner, Thomas Brownlow, using the name Helena Sand and Gravel, acquired adjacent properties in the 1930s and 1940s and opened a gravel pit north of the old foundry and mill complex. They stored and repaired equipment in the stone buildings, two of which still stand today. The sand and gravel operation expanded to include a ready-mix plant and remained in operation at the site until the late 1950s. Helena Sand and Gravel may have removed and relocated some mill tailings deposited on the site from the New York-Montana Testing and Engineering Company operations.

Since 1960, the Stedman Foundry property and associated excavated gravel pit have been used as a gravel pit operation, a headquarters for a construction business, and for land speculation. Montana Fish, Wildlife, and Parks (FWP) first acquired land in the Spring Meadow Lake Park area in 1981.

5.2 FIELD ACTIVITIES

The RI field activities were conducted on April 11 through 12, 2005, and on April 18, 19, and 21, 2005. The field activities at the Spring Meadow Lake site included collecting surface and subsurface solid matrix samples, sediment samples, and surface water samples, and drilling, installing, and developing two groundwater monitoring wells. (The number of samples and the analytical suite are summarized in Table 5-1.) The RI data collection was needed to (1) conduct a risk assessment, (2) complete an EEE/CA (to be documented in Section 6), and (3) select a preferred reclamation alternative. The information required to support the risk assessment, as described in the reclamation work plan (see Section 4), includes:

- Determining the magnitude and extent of potential surface and subsurface soil contamination
- Determining the magnitude and extent of potential sediment contamination
- Determining the magnitude of potential surface water contamination
- Determining the magnitude of potential groundwater contamination with the new monitoring wells

TABLE 5-1
SAMPLE COLLECTION AND ANALYSIS INFORMATION SUMMARY
SPRING MEADOW LAKE SITE

Sample Type	Number of Samples Collected	TAL Metals ^a	Particle Size	Cation Exchange Capacity	Agronomic Analysis ^b	Total Organic Carbon	Water Quality Parameters ^c
Surface soil	12	12					
Subsurface soil	34	34	7	7	7		
Sediment	8	8	0	0	0	8	
Surface water	3	3					3
Groundwater	2	2					2

Notes:

- ^a Target analyte list (TAL) metals include antimony, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, and zinc.
^b Agronomic analysis includes pH, conductivity, N-P-K-, organic matter, and lime and fertilizer recommendations.
^c Water quality analysis includes pH, conductivity, hardness, chloride, and sulfate.

The following evaluations were also performed to support the detailed analysis of reclamation alternatives of the Spring Meadow Lake site (Section 6):

- Develop accurate estimates of the area and volume of solid waste materials requiring removal and reclamation
- Determine the extent of previous removal activities associated with the historical sand and gravel mining at this site
- Determine revegetation requirements for disturbed areas, including liming requirements, solid matrix texture and grain size, fertilizer requirements, percent organic matter, and identification of native plant species
- Identify potential off-site repository sites

The following samples were collected at the Spring Meadow Lake site: (1) solid-matrix samples, including soils collected from the surface and from backhoe pits; (2) surface water and sediment samples from Spring Meadow Lake; and (3) groundwater from two locations. Table 5-1 presents the total number and type of solid-matrix (soils and sediment samples) and water (surface and groundwater) collected and analyzed for the Spring Meadow Lake site. All samples collected during the RI were analyzed using an off-site laboratory. Figure 5-1 (in the back pocket) provides the location of all samples collected during this RI.

The RI field sampling activities are discussed below for the solid-matrix, surface water, and groundwater sampling efforts. Additional detailed information on the specific field sampling procedures used for this RI is described in the Spring Meadow Lake reclamation work plan (Section 4 of this report), which contains the field sampling plan.

5.2.1 Solid-Matrix Sampling

The solid-matrix sample locations were selected to provide spatial and discrete sample data to best characterize the nature and extent of the known (visible) and unknown (buried) mineral processing wastes across the Spring Meadow Lake site. Figure 5-1 shows the sample locations on both the Spring Meadow Lake and the Montana Wildlife Center areas. The focus for the RI solid matrix sampling was to delineate the extent of elevated metal concentrations in soil associated with the historical mill operations at this site. Surface and subsurface soil samples were collected, particularly in areas that were assumed to be affected by the historical custom mill operations, during the initial Abandoned Hard Rock Mine Priority Site Investigation and Hazardous Materials Inventory (Montana DEQ 2004). After the results of the site

investigation had been evaluated, it was confirmed that levels of arsenic, copper, manganese, lead, and zinc were elevated in areas of soil.

Surface and subsurface soil samples were collected during this RI to help define and estimate the volume of soils with metals above the preliminary remediation goals (PRG). The soil samples from the test pits were collected from the sides of the pits or from the backhoe bucket, depending on the depth of the pit. The solid-matrix samples from the test pits were collected from both within the visually observed mill waste materials, as well as from the soil horizon immediately below the wastes. The deeper soil samples were collected from the uppermost buried soil horizons, where applicable.

Only near-shore sediments were collected (at a water depth of 6 inches) during the initial site investigation. Additional sediment samples were collected during this RI throughout the east arm and representative shallow water areas of Spring Meadow Lake. The sediment samples were collected in areas where the water was 2 to 4 feet deep using a Ponar dredge sampler. On June 24, 2005, MWCB and FWP personnel collected additional sediment samples with collocated biotic samples at the Spring Meadow Lake site. These samples were collected to further characterize potential impacts to biotic and aquatic resources from the metal-contaminated tailings deposited near the east arm shoreline (see Figure 5-1). Three additional sediment samples were collected with a soil auger by coring sediments from a 0- to 4-inch depth. Three biotic (dragonflies) samples were collected in the same general locations of the east arm to better assess the potential for impact to the site's biotic and aquatic organisms. Samples were analyzed at an off-site laboratory for 11 total metals.

Physical descriptions of the solid matrix soil and sediment sample locations and the sampled media were recorded in a field logbook. A photocopy of the project field logbook is contained in Appendix 5-A.

In total, 54 solid matrix (46 soil and eight sediment) samples were collected from the Spring Meadow Lake project area. All solid matrix samples were analyzed for 13 target analyte list (TAL) metals at an off-site laboratory using inductively coupled plasma (ICP) spectrometry. Reclamation objectives were met by collecting samples of the buried soil horizons in seven locations and analyzing the soils for particle size (texture), cation exchange capacity (CEC), pH, and agronomic parameters (nitrogen, phosphorus, potassium, and lime and fertilizer recommendations).

5.2.2 Surface Water and Groundwater Sampling

Surface water and groundwater sample locations at the Spring Meadow Lake site were selected to characterize potential impacts to water resources from the activities associated with the historical mill and processing plant (see Figure 5-1). Three surface water samples were collected in Spring Meadow Lake by immersing the sample container directly into the surface water. Separate bottles were collected for analysis of metals and for water quality parameters (pH, conductivity, hardness, chloride, and sulfate). All sample containers were triple rinsed with sample water before the final sample was collected. The surface water samples were sent to an off-site laboratory for analysis.

Two groundwater monitoring wells were drilled at the Spring Meadow Lake site on April 11 and 12, 2005. The wells were drilled using an air-rotary percussion drill rig contracted from O'Keefe Drilling of Butte, Montana. One monitoring well was installed along the southeastern shore of Spring Meadow Lake, and the other well was installed north of the historical mill building in the Montana Wildlife Center. Soil and rock samples were not collected when the monitoring wells were installed because only a small volume of cuttings were generated during drilling.

The monitoring wells were developed on April 21, 2005, using a submersible pump and a multi-parameter water quality probe to establish that field parameters (pH, temperature, conductivity, dissolved oxygen, and oxidation reduction potential [ORP]) had stabilized. Between 12 and 15 gallons of water were pumped from each well before samples were collected. Monitoring well number 1 (MW-01) was drilled to a total depth of 32.55 feet below ground surface (bgs); the water table was measured at about 23 feet bgs on April 21, 2005. MW-02 was completed to a total depth of 29.9 feet bgs; the water table was measured at about 13 feet bgs on April 21, 2005.

The groundwater monitoring wells were sampled on April 21, 2005, immediately after the wells were developed. Groundwater samples were sent to an off-site laboratory for basic water quality tests (pH, electrical conductivity), anions (chloride and sulfate), cation (calcium and magnesium), and water hardness. The concentrations of dissolved metals and other water quality results for groundwater will be used to support selection of the preferred reclamation alternatives for this site.

5.3 SITE AND WASTE CHARACTERIZATION

This section describes the characteristics and analytical results for the solid matrix samples (soils and sediments), surface water samples (Spring Meadow Lake), and groundwater samples (from two monitoring wells) collected for the Spring Meadow Lake RI. Included in this section is information on the various mill waste types, the locations and approximate volumes, and other physical properties of the wastes. Characterization of the waste types is used to assess (1) the potential risk to human health and the environment, and (2) the specific waste material volumes associated with the reclamation alternatives for this site.

Complete analytical results and laboratory reports for all samples are in Appendix 5-B. The analytical data presented in this section are compared with cleanup levels residential, on-site workers, and recreational scenarios based on the conceptual site models for those specific areas of the Spring Meadow Lake property. The recreational-user and site-worker risk scenarios were merged for this screening level risk assessment, and the most conservative cleanup level from either group was used for arsenic and lead. The risk-based cleanup levels and methodology are described in detail in Section 5.5 (Human Health Risk Assessment) and 5.6 (Ecological Risk Assessment).

5.3.1 Spring Meadow Lake – East Arm Area Soils

The east arm at the Spring Meadow Lake site is an open area that includes a recreational walking path that surrounds Spring Meadow Lake. Most of this area is undeveloped park land that was disturbed and used during the previous sand and gravel mining operations. The remnants of various sand and gravel stockpiles are evident, and up to 2 feet of sand remains on the surface in some places. The far northern end (nearest Country Club Lane) was not as disturbed as was the southern area of the site, where the main sand and gravel yard was located. Very little of the aboveground structures remain from the historical hardrock mill or from the sand and gravel operations. Some concrete holding bins for various sand and gravel products and the large concrete base to load railroad cars with sand and gravel are still on site.

The east arm of Spring Meadow Lake site is vegetated with native and introduced grasses, shrubs, and trees. Some nearly barren areas are intermixed with better vegetated area based, to some degree, on the texture and depth of materials that remain on the surface during past uses. Some dominant grasses include Western wheatgrass, thickspike wheatgrass, inland saltgrass, needle-and-thread grass, smooth brome grass, sheep fescue, and cheatgrass. Forbs and shrubs that occur across the site include yellow

sweetclover, fringed sagebrush, prairie sage, woods rose, and Western snowberry. The overstory trees include cottonwood, willow, and dogwood.

Nineteen test pits were completed with a backhoe (TP-151 through TP-169) during the RI of the east arm of the Spring Meadow Lake site. An additional 13 test pits were excavated during the initial site investigation; those data are reported in a previous document (DEQ/MWCB 2004). Figure 5-1 shows the locations of the 13 earlier site investigation test pits and the 19 test pits completed during the RI. To complement the site investigation data, the RI test pits were located to fill data gaps and better define the areal and vertical extent of metals contamination across this site.

A total of 32 non-sediment solid matrix samples were collected from the 19 test pits. Of the 32 solid matrix samples, 10 were collected from surface materials (0 to less than 8 inches bgs) and 22 were from subsurface materials (variable depths to 66 inches bgs). Table 5-2 presents the concentrations of metals in the samples of surface and subsurface material.

Arsenic, lead, and manganese in some East Arm soil samples were at levels above the PRG for direct contact with industrial soils reported by the Region IX Environmental Protection Agency (EPA) (EPA 2002a). No other metals exceeded the EPA PRG values for industrial soil. Arsenic was found to be the primary contaminant of concern, and any potential reclamation or remediation efforts that clean up arsenic-contaminated soils would also clean up areas contaminated by lead and manganese. Arsenic was above the PRG for direct contact with industrial soils in 15 of the 32 solid matrix samples.

Concentrations of arsenic ranged from 21 milligrams per kilogram (mg/kg) (TP-168B) to 10,400 mg/kg (TP-167A). Samples with high arsenic levels (more than 400 mg/kg) were also found to have very high levels of manganese (22,800 to 122,000 mg/kg). The material found to contain high concentrations of both arsenic and manganese is believed to be a mill-tailings waste product from the concentrating and processing of the manganese ores by the New York-Montana Testing and Engineering in 1916 and 1917. Areas with high levels of arsenic and manganese can be visually identified by the monoculture of inland saltgrass (*Distichlis stricta*) and the dark, black, fine-grained granular material on the surface.

TABLE 5-2
SOLID MATRIX METAL CONCENTRATIONS
SPRING MEADOW LAKE SITE
EAST ARM SURFACE AND SUBSURFACE SOILS (mg/kg)

Sample #	Depth (in)	Sb	As	Ba	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Ag	Zn
Industrial Soil PRGs		410	260	67,000	450	450	41,000	100,000	750	19,000	0	20,000	5,100	100,000
TP 151	0-6	< 5	219	112	2	12	29	18300	154	3750	< 0.5	6	< 5	356
TP 152	0-8	< 5	54	56	< 10	74	17	94400	140	2240	< 0.5	9	< 25	81
TP 153 A	0-6	< 5	329	102	3	26	45	33200	247	4620	< 0.5	8	< 5	345
TP 153 B	18-24	< 5	50	71	< 10	52	18	62500	89	1490	< 0.5	7	< 25	106
TP 154 A	8-18	22	879	264	8	31	144	25000	998	41400	0.5	8	14	1460
TP 154 B	60-66	< 5	44	31	< 2	10	15	14200	72	446	< 0.5	< 5	< 5	77
TP 155 A	0-4	17	434	289	5	33	126	20000	677	41700	< 0.5	6	12	1260
TP 155 B	18-24	< 5	37	80	< 2	16	24	21100	75	425	< 0.5	10	< 5	87
TP 156 A	10-12	< 5	101	85	< 2	11	35	17000	83	1070	< 0.5	8	< 5	116
TP 156 B	36-42	9	624	224	6	12	77	18000	572	5340	0.6	8	< 5	908
TP 157 A	4-6	< 5	180	149	3	11	37	16600	146	3030	< 0.5	10	< 5	530
TP 157 B	24-36	< 5	45	133	2	13	20	17700	37	292	< 0.5	9	< 5	62
TP 158 A	6-9	22	1460	422	17	35	218	15600	1310	111000	0.6	< 5	27	3380
TP 158 B	28-32	< 5	62	75	< 2	14	24	17600	76	1420	< 0.5	7	< 5	109
TP 159 A	4-6	15	1290	232	17	16	123	18000	926	29100	< 0.5	6	13	2260
TP 160 A	4-6	61	5400	465	41	28	377	24000	3330	85500	0.9	< 5	50	5730
TP 161 A	0-6	13	804	106	8	14	74	17400	614	12100	< 0.5	< 5	6	841
TP 162 A	0-2	7	126	150	2	16	61	18600	269	15000	< 0.5	< 5	< 5	603
TP 162 B	36-42	5	100	161	< 2	19	73	24500	115	1730	0.6	15	< 5	187

TABLE 5-2 (Continued)
SOLID MATRIX METAL CONCENTRATIONS
SPRING MEADOW LAKE SITE
EAST ARM SURFACE AND SUBSURFACE SOILS (mg/kg)

Sample #	Depth (in)	Sb	As	Ba	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Ag	Zn
Industrial Soil PRGs		410	260	67,000	450	450	41,000	100,000	750	19,000	0	20,000	5,100	100,000
TP 163 A	0-6	< 5	172	155	< 2	11	113	19400	189	5220	< 0.5	10	< 5	274
TP 164 A	0-4	23	754	539	12	40	241	15200	1220	122000	0.5	< 5	30	2680
TP 164 B	16-24	6	461	196	8	17	104	29700	373	4230	< 0.5	12	< 5	1260
TP 165 A	4-6	6	502	136	4	18	66	22900	389	12200	< 0.5	6	< 5	566
TP 166 A	0-4	12	570	194	5	14	102	15800	537	27900	< 0.5	< 5	8	1130
TP 166 B	12-18	< 5	26	44	< 2	5	< 10	7840	20	347	< 0.5	< 5	< 5	36
TP 167 A	14-20	93	10400	494	13	18	265	22400	6180	53200	0.6	< 5	54	2490
TP 167 B	22-24	< 5	101	57	< 2	12	25	15600	82	1210	< 0.5	< 5	< 5	97
TP 168 A	2-6	< 5	37	50	< 2	11	19	15600	37	338	< 0.5	8	< 5	62
TP 168 B	18-24	< 5	21	58	< 2	8	12	13200	30	644	< 0.5	< 5	< 5	48
TP 168 C	26-60	< 5	110	123	< 2	13	49	21500	108	1030	< 0.5	10	< 5	136
TP 169 A	0-6	11	781	202	6	13	103	19100	590	24700	< 0.5	7	7	1050
TP 169 B	6-18	10	609	200	5	15	92	21300	496	22800	< 0.5	7	5	911

Notes:

Bold and highlighted values exceed preliminary remedial goals (PRGs) for industrial soils under direct contact exposure pathways (EPA 2002)
mg/kg Milligrams per kilogram

Lead was also found elevated above the 750 mg/kg PRG for direct contact with industrial soils in nine of the 32 solid matrix samples. Concentrations of lead ranged from 20 mg/kg (TP-166B) to 6,180 mg/kg (TP-167A). Lead is associated with the same mill-tailings wastes and was elevated only in samples that were also very high in arsenic (more than 260 mg/kg).

The source of the elevated concentrations of arsenic appears to be the mill-tailings waste product associated with the manganese concentrating and processing in 1916 and 1917. The dark black mill tailing was likely disposed of in the east arm of the Spring Meadow Lake site and has subsequently eroded and was displaced by later sand and gravel operations.

5.3.2 Spring Meadow Lake – East Arm Sediments

The actual east arm of Spring Meadow Lake is a seasonally, to near permanently, ponded area with water depths varying from a few inches to about 6 feet deep. The east arm area was not mined for sand and gravel but was excavated to develop fish habitat (RTI 2005). The east arm has naturally revegetated and supports a healthy vegetation community and the recreational uses associated with the Spring Meadow Lake State Park.

Sediment samples were collected at eight locations in the east arm and southeastern portion of Spring Meadow Lake during the RI. A Ponar dredge sampler was used to collect sediment from the upper 2 inches of sediment at each location. Water depths were recorded and vary from about 2 feet (SD-201, SD-202, SD-205, and SD-208) to 6 feet (SD-206). The depths of water at the other sediment sample location were estimated at 3 feet (SD-204, SD-207) and 4 feet (SD-203). Ten near-shoreline sediment samples were collected from the site (SD-101 through SD-112; but not SD-104 or SD-105) during the initial site investigation. In June 2005, DEQ MWCB and FWP collected three collocated sediment and aquatic insect samples. The aquatic insect sampling is described in Section 5.3.3 below. Analytical results for sediment from these three investigations are provided in Table 5-3. Figure 5-1 shows the locations for the 10 site investigation sediment samples, 8 RI sediment samples, and 3 collocated DEQ and FWP sediment samples.

TABLE 5-3
METAL CONCENTRATIONS IN SOLID MATRIX
SPRING MEADOW LAKE SITE EAST ARM SEDIMENTS (mg/kg)

Sample #	Investigation	Depth (in)	Sb	As	Ba	Cd	Cr	Cu	Fe	Pb	Hg	Ni	Ag	Zn
Sediment Goals			2.9	19		7.5				240	0.16	39		500
SD 201	RI	0-2	<	95	77	<	8	25	10800	135	<	<	<	198
SD 202	RI	0-2	<	34	54	<	7	19	9550	53	<	<	<	83
SD 203	RI	0-2	<	19	52	<	10	15	9840	64	<	<	<	82
SD 204	RI	0-2	<	32	116	<	10	42	9560	163	<	<	<	218
SD 205	RI	0-2	<	31	120	<	10	38	14300	130	<	<	<	185
SD 206	RI	0-2	<	20	98	<	6	24	6420	70	<	<	<	93
SD 207	RI	0-2	<	105	121	<	5	39	6940	70	<	<	<	314
SD 208	RI	0-2	<	110	130	<	6	78	14800	319	<	<	<	619
SD 101	SI	0-2	<	13	29	<	36	14	39200	48	<	<	<	78
SD 102	SI	0-2	<	10	39	<	57	16	47700	79	<	<	<	88
SD 103	SI	0-2	<	10	46	<	56	<	48900	31	<	<	<	38
SD 106	SI	0-2	<	10	27	<	25	<	26400	16	<	<	<	25
SD 107	SI	0-2	<	10	31	<	8	24	11200	14	<	<	<	25
SD 108	SI	0-2	<	<	40	<	17	33	18100	39	<	<	<	37
SD 109	SI	0-2	65	136	108	3	13	112	9070	105	0.2	<	<	310
SD 110	SI	0-2	27	2130	270	14	40	156	18700	1480	0.4	<	<	2280
SD 111	SI	0-2	<	12	42	<	16	15	16000	38	<	<	<	76
SD 112	SI	0-2	21	726	291	10	35	96	22200	1030	0.2	<	<	1150
SML 301SD	DEQ/FWP	0-4	<	15	36	<	6	13	7800	27	NA	NA	NA	46
SML 302SD	DEQ/FWP	0-4	<	50	55	<	14	20	16100	53	NA	NA	NA	88
SML 303SD	DEQ/FWP	0-4	<	17	41	<	6	15	8420	28	NA	NA	NA	47

Notes:

mg/kg Milligrams per kilogram

Bold and highlighted values exceed Washington State Freshwater Sediment Quality PAET Values (Washington State Dept. of Ecology 1997)

SD Sediment sample prefix

SI Site investigation sample

RI Reclamation investigation sample

DEQ/FWP DEQ and FWP sediment and aquatic insect sampling on June 24, 2005

< Less than the method detection limit

The contaminant of concern for the sediments in the east arm of Spring Meadow Lake is arsenic. Seven of the eight RI sediment samples contained arsenic above the Washington State Freshwater Sediment Quality Probable Apparent Effects Threshold (PAET) value (19 mg kg) that Montana DEQ uses for screening sediment. Three of the eight arsenic values in sediment samples (SD-201, SD-207, and SD-208) appear to contain higher concentrations (95 to 110 mg kg) than the other five (19 to 34 mg kg). Results for three of the 10 initial site investigation sediment samples, and for one of the three DEQ and FWP sediment samples, also exceeded the screening level. Background levels for arsenic in sediment were not established for the Spring Meadow Lake site but may be in the range of 19 to 34 mg kg.

5.3.3 Spring Meadow Lake – Biological Sampling

The DEQ and FWP collect collocated sediment and aquatic insect samples in the east arm area of Spring Meadow Lake on June 24, 2005, to evaluate the potential biological uptake of arsenic and other metals from sediment. Three samples of dragonfly nymphs were collected with a net at locations shown on Figure 5-1. The insect samples were analyzed at an off-site laboratory for total metals. On July 29, 2005, FWP collected samples of bass (composite of five fish) and pumpkinseed (composite of five fish) and analyzed them for total arsenic at the State of Montana environmental laboratory. The results for the insect and fish samples are provided in Table 5-4.

5.3.4 Spring Meadow Lake - Montana Wildlife Center Area

The Montana Wildlife Center area of the Spring Meadow Lake site was the original Stedman Foundry property that was also used as a custom mill for processing gold-silver and manganese ores and as the yard and facility area for the sand and gravel mining operation. One of the old stone and wooden buildings burned substantially in December 2003. The remaining stone walls and concrete floor were demolished and hauled off site in early 2004, and the area has been regraded and covered with gravel. The Montana Wildlife Center has built several new chain-link fenced pens and shelters for wildlife. The Montana Wildlife Center opened in March 2004 and is currently operating.

TABLE 5-4

**METALS CONCENTRATIONS IN BIOLOGICAL (AQUATIC INVERTEBRATES AND FISH) SAMPLES
SPRING MEADOW LAKE SITE -EAST ARM AREA (mg/kg)**

ID	Sample #	Date Collected	Sb	As	Ba	Cd	Cr	Cu	Fe	Pb	Mn	Tl	Zn
Aquatic Invertebrates Screening Level ^a				30 - 50									
Fish Screening Level ^b				1 - 3									
SML	301 BUGS	6/24/05	<0.4	0.6	2	0.07	<0.6	4.4	1080	1	17	<0.1	12
SML	302 BUGS	6/24/05	<0.4	3.9	5.5	0.09	<0.6	3.0	1820	6.2	303	<0.1	17
SML	303 BUGS	6/24/05	<0.4	2.6	3.3	<0.06	<0.6	4.5	800	1	98	<0.1	14
SD	Bass	7/29/05	NA	0.6	NA	NA	NA	NA	NA	NA	NA	NA	NA
SD	Pumpkinseed	7/29/05	NA	0.3	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

mg/kg Milligrams per kilogram

Highlighted values for arsenic screening values in aquatic invertebrates and fish:

^a^b

USDI, 1998. Guidelines for Interpretation of the Biological Effects of Selected Constituents in Biota, Water, and Sediment - Arsenic

Gilderhus, 1966. Some Effects of Sublethal Concentrations of Sodium Arsenite on Bluegills and the Aquatic Environment

Sb=antimony; As=arsenic; Ba=barium; Cd=cadmium; Cr=chromium; Cu=copper; Fe=iron; Pb=lead; Mn=manganese; Tl=thallium; Zn=zinc

Not analyzed

Metals

NA

The focus of the RI for the Montana Wildlife Center was to better define the nature and extent of subsurface contamination identified during the site investigation. Six backhoe test pits (TP-169 through TP-174) were excavated in areas of the Montana Wildlife Center that had not been previously characterized. Solid matrix samples were collected from 15 test pits dug with a backhoe during the initial site investigation (DEQ-MWCB 2004), revealing buried floatation mill tailings in at least one area near the east side of the burned building. The additional six RI test pits were located to further define the horizontal and vertical extent of the potentially contaminated surface and subsurface wastes. Surface soils around the remaining two buildings were adequately sampled and characterized during the site investigation; therefore, only two additional surface soil samples were collected during the RI. Figure 5-1 shows the locations for the 15 previous site investigation test pits and the six RI test pits. Table 5-5 presents the concentrations of metals in the RI samples for the Montana Wildlife Center.

Fourteen total solid matrix samples were collected in the Montana Wildlife Center during this RI. Twelve of the solid matrix samples were from subsurface materials (10 to 38 inches bgs) and two were surface material samples (0 to 9 inches bgs). The contaminants of concern were arsenic, lead, and mercury. In general, these contaminants are similar to those for the Spring Meadow Lake east arm but included some higher levels of cadmium, copper, and mercury that may be associated with the early foundry wastes, disposal of floatation tailings, and other mill process wastes associated with Northwestern Metals operations from 1910 to 1915.

For this RI, only three of the 14 solid matrix samples (TP-171A, TP-173A, and TP-173B) contained any metals at concentrations above the PRGs for direct contact with industrial soil (Table 5-5).

Concentrations of arsenic were above the PRG for industrial soil (260 mg/kg) in two of these three samples. Sample TP-173A contained lead and manganese at concentrations above the PRGs for industrial soil, but the arsenic level was at 158 mg/kg, below the PRG for arsenic in industrial soil.

Arsenic values in the 14 solid matrix samples ranged from 43 mg/kg to 33,700 mg/kg.

Sample TP-171A contained mercury at a detectable concentration of 2.1 mg/kg, along with very high levels of arsenic (33,700 mg/kg), lead (16,300 mg/kg), and manganese (60,000 mg/kg). Sample TP-173B also contained high levels of arsenic (1,240 mg/kg), lead (3,010 mg/kg) and manganese (36,900 mg/kg). Visual characterization of this material revealed that it was black to orange- and brown-stained wastes that may have been associated with the earliest foundry (see page 105 of the logbook).

TABLE 5-5
METALS CONCENTRATIONS IN SOLID MATRIX
SPRING MEADOW LAKE SITE
MONTANA WILDLIFE CENTER AREA (mg/kg)

Sample #	Depth (in)	Sb	As	Ba	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Ag	Zn
Industrial Soil PRGs		410	260	67,000	450	450	41,000	100,000	750	19,000	0	20,000	5,100	100,000
TP 170 A	4-6	< 5	< 10	46	< 2	13	19	16300	18	340	< 0.5	7	< 5	52
TP 170 B	20-28	47	< 50	78	< 10	32	99	103000	567	952	< 0.5	22	< 25	78
TP 170 C	32-38	< 5	61	140	< 2	10	29	14900	60	444	< 0.5	7	< 5	83
TP 171 A	2-12	280	33700	581	78	17	1290	61200	16300	60000	2.1	< 5	106	5940
TP 171 B	12-20	< 5	59	98	< 10	21	46	71900	60	1260	< 0.5	17	< 25	92
TP 171 C	30-36	< 5	43	142	< 2	12	24	16400	31	305	< 0.5	9	< 5	53
TP 172 A	18-20	< 5	30	64	< 2	10	21	15000	52	333	< 0.5	6	< 5	76
TP 173 A	0-9	9	158	773	14	48	350	18000	1290	224000	< 0.5	< 5	31	3370
TP 173 B	10-20	21	1240	343	246	24	253	53100	3010	36900	0.7	11	15	48400
TP 173 C	22-24	< 5	54	172	< 2	10	22	15000	27	448	< 0.5	9	< 5	93
TP 174 A	0-8	< 5	76	180	4	17	53	19300	298	18000	< 0.5	9	< 5	1050
TP 174 B	14-16	< 5	65	79	< 2	11	24	17800	55	391	< 0.5	8	< 5	80
TP 174 C	18-20	< 5	11	79	< 2	10	65	32600	84	396	< 0.5	12	< 5	69
TP 174 D	30-32	< 5	39	127	< 2	13	22	18200	33	407	< 0.5	9	< 5	89

Notes:

mg/kg Milligrams per kilogram

Bold and highlighted values exceed preliminary remedial goals (PRGs) for industrial soils under direct contact exposure pathways (EPA 2002)

TP Test pit prefix

A Uppermost sample in test pit

B Second sample in test pit – below A

C Third sample in test pit – below A and B

D Lowest sample in test pit – below A, B, and C

< Less than the method detection limit reported

5.3.5 Background Soil

The Spring Meadow Lake site is located near the Tenmile Creek floodplain and is underlain by sands and gravels from mixed igneous, limestone, and sandstone formations that were deposited by glacial outwash during the Pleistocene age (USDA-NRCS 2003). The alluvium parent materials for the soils that developed at this site were influenced by historical Tenmile Creek channel locations and by local depositional areas. The pre-disturbed soil type mapped for the Spring Meadow Lake site is the Meadowcreek-Fairway complex, 0 to 2 percent slopes (USDA-NRCS, 2003). This soil, if undisturbed, would have loam-textured upper horizons overlying more coarse sandy loam subsurface horizons. These soils are moderately deep (35 inches) grading to gravelly sand from 35 to 60 inches bgs.

Nearly the entire Spring Meadow Lake site has been disturbed by past mineral processing, sand and gravel mining, or more recent uses. Even in areas that were not excavated, waste materials and common earthen fill have been deposited. A confirmed undisturbed background soil was not identified during the site investigation or the RI. However, the upper material (a few inches to several feet) was disturbed but the soils at depth (highly variable) appeared to have developed in place at several locations. Samples from these buried native soils were collected primarily to establish and define the lower boundary for potential removal efforts. Because these buried soils were visually determined to be undisturbed buried soil horizons, their concentrations of metals can be used to estimate background levels of metals in soil. Background levels of metals in soil are needed to complete the ecological risk assessment (Section 5.6). Three soil samples (TP-154B, TP-155B, and TP-166B) were used to estimate background concentrations of metals and are shown in Table 5-6. The locations for these test pits are shown on Figure 5-1.

5.3.6 Surface Water

Three surface water samples were collected from Spring Meadow Lake during the RI. Figure 5-1 shows the surface water sampling locations. Sample SW-201 was collected from the center part of the east arm of Spring Meadow Lake. Sample SW-202 was collected from a central area of the main Spring Meadow Lake body. Sample SW-203 was collected from the southern end of the east arm. In addition to the three samples collected during the RI, 12 samples were collected during the initial site investigation and were reported in a previous document (DEQ-MWCB 2004). Analytical results for all 15 surface water samples are provided in Table 5-7.

TABLE 5-6

**BACKGROUND METALS CONCENTRATIONS IN SOIL
SPRING MEADOW LAKE SITE (mg/kg)**

Sample #	Depth (in)	Sb	As	Ba	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Ag	Zn
TP 154 B	60-66	< 5	44	31	< 2	10	15	14200	72	446	< 0.5	< 5	< 5	77
TP 155 B	18-24	< 5	37	80	< 2	16	24	21100	75	425	< 0.5	10	< 5	87
TP 166 B	12-18	< 5	26	44	< 2	5	< 10	7840	20	347	< 0.5	< 5	< 5	36
Average values		5	35.7	51.7	2	10.3	16.3	14380	55.7	406	0.5	6.7	5	66.7

Notes:

mg/kg Milligrams per kilogram

in. Inches below ground surface

TP Test pit prefix

B Second sample collected in test pit – below A

TABLE 5-7

**METALS CONCENTRATIONS (Total Recoverable and Dissolved) IN SURFACE WATER
SPRING MEADOW LAKE SITE (mg/L)**

Sample #	SI or RI	Sb	As	Ba	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Ag	Zinc
WQB-7 Values		0.006	0.018	2.000	0.005	0.100	1.300	0.300	0.015	0.050	0.00005	0.100	0.100	2.000
SW 201	RI-TM	< 0.003	0.012	0.029	0.0001	<0.001	< 0.001	0.02	< 0.003	0.005	< 0.00006	< 0.02	< 0.003	< 0.01
SW 202	RI-TM	< 0.003	0.012	0.037	0.0001	<0.001	< 0.001	0.02	< 0.003	0.011	< 0.00006	< 0.02	< 0.003	< 0.01
SW 203	RI-TM	< 0.003	0.032	0.009	0.0001	<0.001	0.001	0.06	< 0.003	0.051	< 0.00006	< 0.02	< 0.003	< 0.01
SW 201	RI-DM	< 0.003	0.012	0.030	0.0001	0.004	0.002	< 0.01	< 0.003	< 0.005	< 0.00006	< 0.02	< 0.003	< 0.01
SW 202	RI-DM	< 0.003	0.011	0.037	0.0001	0.005	0.006	< 0.01	< 0.003	< 0.005	< 0.00006	< 0.02	< 0.003	< 0.01
SW 203	RI-DM	< 0.003	0.030	0.012	0.0001	0.003	0.003	0.01	< 0.003	0.018	< 0.00006	< 0.02	< 0.003	< 0.01
SW 101	SI-TM	< 0.003	0.009	0.024	< 0.0001	<0.001	< 0.001	0.11	< 0.003	0.017	N/A	< 0.02	< 0.0005	0.01
SW 102	SI-TM	< 0.003	0.017	0.023	< 0.0001	<0.001	0.001	0.05	< 0.003	0.007	N/A	< 0.02	< 0.0005	0.01
SW 103	SI-TM	< 0.003	0.017	0.022	< 0.0001	< 0.001	< 0.001	0.05	< 0.003	0.005	N/A	< 0.02	< 0.0005	< 0.01
SW 104	SI-TM	< 0.003	0.017	0.029	< 0.0001	< 0.001	0.001	0.16	< 0.003	0.01	N/A	< 0.02	< 0.0005	< 0.01
SW 105	SI-TM	< 0.003	0.017	0.031	< 0.0001	< 0.001	0.001	0.08	< 0.003	0.01	N/A	< 0.02	< 0.0005	< 0.01
SW 106	SI-TM	< 0.003	0.016	0.031	< 0.0001	< 0.001	0.001	0.06	< 0.003	0.007	N/A	< 0.02	< 0.0005	< 0.01
SW 107	SI-TM	< 0.003	0.017	0.032	< 0.0001	< 0.001	0.001	0.12	< 0.003	0.008	N/A	< 0.02	< 0.0005	< 0.01
SW 108	SI-TM	< 0.003	0.017	0.030	< 0.0001	< 0.001	0.001	0.03	< 0.003	0.009	N/A	< 0.02	< 0.0005	< 0.01
SW 109	SI-TM	< 0.003	0.019	0.030	< 0.0001	< 0.001	0.001	0.09	< 0.003	0.009	N/A	< 0.02	< 0.0005	< 0.01
SW 110	SI-TM	< 0.003	0.240	0.015	< 0.0001	< 0.001	0.001	0.14	< 0.003	0.38	N/A	< 0.02	< 0.0005	< 0.01
SW 111	SI-TM	< 0.003	0.017	0.030	< 0.0001	< 0.001	0.001	0.05	< 0.003	0.011	N/A	< 0.02	< 0.0005	< 0.01
SW 112	SI-TM	< 0.003	0.020	0.025	< 0.0001	< 0.001	0.001	0.21	< 0.005	0.066	N/A	< 0.02	< 0.0005	0.02

Notes:

mg/L Milligrams per liter

WQB-7

Montana Department of Environmental Quality, Numeric Water Quality Standards, Circular, January 2004

Bold and highlighted values exceed Montana Numeric Water Quality Standards

SW Surface water sample prefix

RI-TM Reclamation Investigation samples total recoverable metals analysis

RI-DM Reclamation Investigation samples dissolved metals analysis

SI-TM Site Investigation samples total metals analysis

< Less than the Method Detection Limit reported

N/A Not analyzed

The surface water samples from Spring Meadow Lake were analyzed for both total and dissolved metals. Only the values for total metals are comparable to the DEQ water quality standards (DEQ 2004). The RI surface water samples were also analyzed for standard water quality parameters, including pH, electrical conductivity, chloride, sulfate, and hardness (as CaCO₃). The standard water quality parameters are provided in Table 5-8.

TABLE 5-8
SURFACE WATER – STANDARD WATER QUALITY RESULTS
SPRING MEADOW LAKE SITE

Sample	Location	pH (SU)	Electrical Conductivity (µmhos/cm)	Chloride (mg/L)	Sulfate (mg/L)	Hardness as CaCO ₃ (mg/L)
SW-201	East Arm – Central area	8.9	366	15	44	128
SW-202	Spring Meadow Lake – Center	8.4	386	15	44	153
SW-203	East Arm – South end	9.2	278	13	36	102

Notes:

SU Standard units
µmhos/cm Micromhos per centimeter
mg/L Milligrams per liter

The results for surface water samples indicate that the water in the east arm of Spring Meadow Lake contains arsenic and manganese at concentrations above Montana's human health standards for surface water (0.018 milligrams per liter [mg/L] for arsenic and 0.05 mg/L for manganese). Surface water sample SW-110 contained arsenic at a concentration of 0.24 mg/L and manganese at a concentration of 0.38 mg/L. Sample SW-110 was collected in the far southern end of the east arm, where visible mill tailings have been deposited along the shoreline and washed into the seasonally submerged zone. Surface water sample SW-112 was collected along the eastern side of the east arm and also contained arsenic and manganese at concentrations above the human health standards. The arsenic level in sample SW-112 was 0.02 mg/L and the manganese level was 0.066 mg/L, both just above the standards. Samples SW-110 and SW-112 were collected with collocated sediment samples (SD-110 and SD-112) that contained elevated concentrations of arsenic (2,130 and 726 mg/kg), manganese (48,800 and 25,000 mg/kg), lead (1,480 and 1,030 mg/kg) and zinc (2,280 and 1,150 mg/kg). The surface water in the east arm (southern portion) of Spring Meadow Lake appears to be affected by the metals in the mine tailings that have been deposited along the shoreline.

5.3.7 Groundwater

Very little previous data were available about groundwater quality in the Spring Meadow Lake area. Two monitoring wells were strategically located to evaluate whether surface and subsurface contaminated materials were affecting groundwater. Monitoring well MW-1 is located on the flat bench downgradient (north) of the former Stedman Foundry and custom milling and processing buildings. This location was selected to monitor the quality of groundwater below and slightly downgradient of the Montana Wildlife Center. The gradient of groundwater below the Montana Wildlife Center is believed to be generally to the north, toward Spring Meadow Lake.

Monitoring well MW-2 was drilled along the eastern side of the east arm and was situated to evaluate any potential impacts from the contaminated surface materials on groundwater in that area. The general groundwater gradient in the east arm area is also mostly north, but may have a northwestern component.

Groundwater samples were collected from both monitoring wells on April 21, 2005, the first samples collected and analyzed from these wells. The water samples were analyzed for 13 dissolved metals and for general water quality parameters (pH, electrical conductivity, chloride, sulfate, and hardness). The groundwater results are shown in Table 5-9, and the monitoring well locations are shown on Figure 5-1.

The results indicate that shallow groundwater under the Montana Wildlife Center contains elevated levels of arsenic and manganese. The concentration of arsenic (0.029 mg/L) was above the Montana human health standard for groundwater of 0.02 mg/L. The concentration of manganese in the sample from well MW-01 (0.39 mg/L) was above the Montana standard (secondary maximum contaminant level of 0.05 mg/L), which is based on a manganese level that may interfere with specified uses. No other metals were elevated in the sample from well MW-01. The groundwater sample from well MW-02 contained detectable levels of arsenic and manganese, but no concentrations of the metals exceeded the water quality standards.

TABLE 5-9

**METALS CONCENTRATIONS IN GROUNDWATER AND WATER QUALITY PARAMETERS
SPRING MEADOW LAKE SITE**

Sample #	Sb	As	Ba	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Ag	Zinc
Dissolved Metals Concentrations (mg/L)													
WQB-7	0.006	0.020	2.000	0.0050	0.100	1.300	0.30 ^a	0.015	0.050 ^a	0.0020	0.10	0.100	2.00
MW 1	< 0.003	0.029	0.041	0.0001	0.008	0.005	< 0.01	< 0.003	0.390	< 0.0006	< 0.02	< 0.003	< 0.01
MW 2	< 0.003	0.010	0.043	0.0004	0.008	0.002	< 0.01	< 0.003	0.007	< 0.0006	< 0.02	< 0.003	0.04
Standard Water Quality Parameters (units defined)													
	pH (S.U.)	EC (µmhos/cm)	Chloride (mg/L)	Sulfate (mg/L)	Hardness as CaCO ₃ (mg/L)								
MW 1	7.6	587	23	84	267								
MW 2	7.5	615	25	70	271								

Notes:

mg/L Milligrams per liter

WQB-7 Montana Department of Environmental Quality, Numeric Water Quality Standards, Circular, January 2004

Bold and highlighted values exceed Montana Numeric Water Quality Standards for groundwater

MW Monitoring well sample prefix

S.U. Standard units

µmhos/cm Micromhos per centimeter

5.4 RECLAMATION AND LAND USE CHARACTERIZATION

Physical and agronomic (nutrient) characteristics of selected soils were evaluated to evaluate whether the soils could support reclamation plant communities and future land uses. Visual observations indicated that contaminated materials are restricted to the surface on portions of the site, and that at depth the soils are essentially undisturbed. The undisturbed buried soils may, however, lack physical or agronomic properties needed to maintain self-perpetuating plant communities after reclamation. The anticipated reuse of the Spring Meadow Lake east arm is recreational and may be used for future park expansion and development. The Montana Wildlife Center is in the conceptual design phase for development of expanded educational and wildlife rehabilitation efforts.

An on-site repository may not be desirable and may alter future parkland development because the Spring Meadow Lake site is a state park. Conceptually, an area is available in the currently undeveloped eastern portion of the state park to handle a potential waste repository, and the physical characteristics of the site would not be a major constraint. The repository would need to extend above the existing land surface, however, because groundwater is shallow in this area. Some small quantities of borrow and fill materials may be obtained on site but would be limited by the shallow depth to groundwater and intended future land use.

5.4.1 Particle Size Analysis

Particle size analysis is a measurement of the size distribution of individual particles in a solid-matrix sample. Particle size distribution is used to measure and evaluate soil texture, sedimentation and alluvial processes, structural and construction purposes, many basic soil science properties (shrink-swell, plasticity, and other properties), and to predict hydraulic properties such as water-holding capacity and unsaturated hydraulic conductivity. Several particle size classification systems are defined; the U.S. Department of Agriculture (USDA) classification system is one of the most common and is used in this RI report. The USDA classification system defines soil particles smaller than 2,000 micrometers (μm) or microns into three major size groups:

- Sands (less than 2,000 μm to 50 μm),
- Silts (less than 50 μm to 2 μm),
- Clays (less than 2 μm).

Particle size was analyzed in four samples from the Spring Meadow Lake site; the results are listed in Table 5-10. The laboratory report is in Appendix 5-B. Samples were collected from true pedological soil horizons that were buried by past site activities, or from the native alluvial materials.

TABLE 5-10
PARTICLE SIZE ANALYSIS
SPRING MEADOW LAKE SITE

Sample ID	Description	Depth (in)	Texture	Particle Size Distribution		
				% Sand	% Silt	% Clay
TP-156B	Buried Soil	36-42	Loam	51.1	31.2	17.5
TP-157B	Buried Soil	24-36	Loam	43.8	36.2	20.0
TP-167B	Buried Alluvium	22-24	Sand	88.8	8.7	2.5
TP-169B	Buried Soil	6-18	Sandy Loam	67.5	23.7	8.8

Samples TP-156B and TP-157B had loam soil textures, which is favorable for revegetation at this site. Sample TP-167B was collected from the buried in-place alluvium material near the east arm. This material was very coarse-textured (sand) and would require amending with finer-textured soil or organic matter before revegetation would be successful. Sample TP-169B was collected from buried sandy loam material that may have been partially mixed with or affected by mill processing wastes. This sample contained arsenic at a concentration of 609 mg/kg, indicating some metals added from leaching or mixing. The native alluvial gravels were at 4.5 to 5 feet bgs at this test pit location.

5.4.2 Cation Exchange Capacity

CEC is a measure of the quantity of readily exchangeable cations that can neutralize the negative charges in the materials or soil. Samples selected for CEC analysis were collected from true soil horizons that were buried by past site activities, or from the native alluvium. In general, soils with finer textures and higher percentages of clay will have more internal surface areas and higher CECs. The negative charges are derived primarily from isomorphous substitution within clay minerals and broken bonds at the mineral edges and surfaces. Isomorphic substitution creates a permanent charge and is independent of the pH. The mineral edge charge, however, is variable and depends on pH and other properties. CEC is useful for evaluating the potential concentrations of plant-available metals that are readily exchangeable in the plant-growth media and are potentially phytotoxic.

CEC was analyzed in seven soil samples from the Spring Meadow Lake site. The results are presented in Table 5-11; a copy of the laboratory report is in Appendix 5-B. The CECs of the four buried upper horizon soil samples (assumed to be buried topsoil materials) had higher CEC values that ranged from 21.5 to 11.9 meq/100g. The CECs of the three buried gravelly and disturbed soils had much lower CECs that ranged from 7.8 to 5.0 meq/100g.

TABLE 5-11
CATION EXCHANGE CAPACITY (CEC)
SPRING MEADOW LAKE SITE

Sample #	Description	Depth (in)	CEC (meq/100g)
TP-156B	Buried Soil	36-42	16.4
TP-157B	Buried Soil	24-36	11.9
TP-158B	Buried Gravelly Sand	28-32	5.6
TP-162B	Buried Soil	36-42	21.5
TP-164B	Buried Soil (disturbed)	16-24	18.3
TP-167B	Buried Alluvium	22-24	5.0
TP-169B	Buried Soil (disturbed)	6-18	7.8

Notes: meq/100g Milliequivalents per 100 grams of soil

The buried topsoil horizons at the Spring Meadow Lake site have moderately high CEC values that indicate they are suitable for revegetation. The low CECs for the buried alluvium and disturbed soil indicate that these materials will need to be covered with finer-textured coversoil or amended with organic matter before they can be revegetated.

5.4.3 Agronomic Analysis

Complete agronomic or agricultural analysis is used to evaluate the potential fertility and plant nutrient availability in the buried soils. Agronomic analysis includes pH; nitrate, phosphorous, potassium (N-P-K); and electrical conductivity (salt hazard). A fertilizer can be recommended from the data when the predicted future crop or pasture use is included. Agronomic analysis is helpful for assessing the potential for in situ revegetation and to estimate the amount of fertilizer and other amendments that may be needed.

The same seven samples analyzed for CEC were also submitted for the agronomic analysis. The results are provided in Table 5-12; the laboratory test results in Appendix 5-B. All soil samples were slightly to moderately alkaline (pH 7.5 to 8.1) and contained very low levels of N-P-K for soils. These soil samples

were from subsurface depths, and their level of fertility would not be expected to be high. Levels of electrical conductivity (EC) were low in six of the seven soil samples, which would be expected for relatively clean (not contaminated) coarse-textured soils. Sample TP-156B is moderately saline (4 to 8 millimhos per centimeter [mmhos/cm]), which indicates that it has been affected by additional salts that have leached from the contaminated materials above. The concentration of arsenic in sample TP-156B was 624 mg/kg, and the concentration of manganese was 5,340 mg/kg. This buried soil has likely accumulated metals and may not support a desirable plant community unless amendments are provided.

TABLE 5-12

**AGRONOMIC ANALYSIS
SPRING MEADOW LAKE SITE**

Sample #	Description	pH (SU)	Nitrate as N (mg/kg)	Phosphorous (mg/kg)	Potassium (mg/kg)	Electrical Conductivity (mmhos/cm)
TP-156B	Buried Soil	7.5	1.35	151	510	4.22
TP-157B	Buried Soil	7.8	1.78	<4	130	0.34
TP-158B	Buried Gravelly Sand	7.8	<1.5	<4	50	0.46
TP-162B	Buried Soil	7.9	1.37	9	260	0.77
TP-164B	Buried Soil (disturbed)	7.6	1.02	34	260	2.62
TP-167B	Buried Alluvium	8.1	0.39		60	0.31
TP-169B	Buried Soil (disturbed)	7.9	0.53	34	100	0.34

Notes:

TP Test pit sample prefix
 SU Standard units
 mg/kg Milligrams per kilogram
 mmhos/cm Millimhos per centimeter

5.5 HUMAN HEALTH RISK ASSESSMENT

A screening-level human health risk assessment was conducted for the Spring Meadow Lake site as part of the RI performed in the spring of 2005. The risk assessment was conducted using current guidance set forth by EPA (1989a). The risk assessment has been updated in this RI to reflect refined land use areas and to include additional data gathered at the site. Risk assessment data and calculation spreadsheets are in Appendix 5-C.

The assessment involved five steps: (1) hazard identification; (2) exposure assessment; (3) toxicity assessment; (4) risk characterization; and (5) calculation of risk-based cleanup goals. The following sections discuss these five steps in greater detail.

5.5.1 Hazard Identification

Hazard identification establishes the contaminants of concern (COC) for the site. Each COC must meet four criteria established by EPA (1989a): (1) the constituent is present at the site; (2) the measured constituent concentrations must be significantly above background concentrations; (3) 20 percent of the measured constituent concentrations must be above the method detection limit; and (4) the analytical results for each constituent must meet the quality assurance quality control (QA/QC) criteria established for the data set.

Forty-six solid matrix samples, 8 sediments, 3 surface waters, and 2 groundwater samples were collected and analyzed for 13 TAL metals during this Spring Meadow Lake RI. In addition, 20 solid matrix, 10 sediment, and 12 surface water samples were collected and analyzed for 12 TAL metals during the site investigation. All data on total metals from 66 solid matrix samples, 20 sediment samples, 15 surface water samples, and 2 groundwater samples meet the EPA criteria for use in assessing risk. All samples were analyzed at an off-site laboratory using EPA contract laboratory procedure (CLP) methods and procedures. An additional 84 surface and subsurface samples were analyzed with a field portable x-ray fluorescence (XRF) spectrometer during the initial site investigation (DEQ-MWCB 2004).

The contaminants of concern for this site that met the requirements for limits of detection and QA/QC and that pose the greatest risks to site users are arsenic and lead. The data were screened against the Region IX EPA industrial soil direct contact PRGs. Arsenic, lead, manganese, and mercury were detected in at least one sample at concentrations greater than the industrial PRG for direct contact with soil PRG. All other metals (antimony, barium, cadmium, chromium, copper, iron, nickel, silver, and zinc) were not detected at concentrations greater than the PRG for industrial soil.

Surface water samples were collected from the Spring Meadow Lake and the small pond during the site investigation and this RI. The samples were analyzed for the same 13 TAL metals plus water quality parameters at an off-site laboratory. Concentrations of metals in the surface water samples were similar to the metals and concentrations found in the collocated sediment samples and the mill waste materials on the nearby shorelines.

Groundwater samples were collected from two monitoring wells. The only constituents detected in the groundwater samples at concentrations greater than drinking water standards were arsenic and manganese.

5.5.2 Exposure Assessment

The exposure assessment identifies the human receptors who may be exposed, the exposure routes through which the receptors may come into contact with hazardous constituents, and the assumptions and data used to quantify the exposure. The main exposure scenarios developed for the Spring Meadow Lake site are:

- Spring Meadow Lake – east arm Area = recreational use
- Spring Meadow Lake – Montana Wildlife Center = on-site worker

The Spring Meadow Lake east arm is undeveloped open space that may be ultimately developed for higher recreational use. Certain areas of the Montana Wildlife Center are open to the public (recreational use), but the entire site is used by on site workers. The future development plans for the Montana Wildlife Center and for the undeveloped areas of Spring Meadow Lake are uncertain.

Risks to recreational receptors at the Spring Meadow Lake east arm were screened using standard risk assessment exposure scenarios for children and adult recreational users. This recreational user scenario was developed based on EPA risk assessment protocols with input from DEQ and the Montana FWP. Children and adults were evaluated separately. The exposure scenario parameters are listed in Section 5.5.4. The potential for recreational use at Spring Meadow Lake is considered high due because it is a state park located near Helena.

The concentration of arsenic ranged from 21 to 10,400 mg/kg, with a mean of 837 mg/kg and a 95th percentile upper confidence level (95% UCL) value of 1,413 mg/kg for the Spring Meadow Lake east arm. Lead concentrations in the east arm ranged from 20 to 6,180 mg/kg, with an average of 631 mg/kg and a 95% UCL value of 976 mg/kg. Thirty-two samples (10 surface and 22 subsurface soil samples) were used in the calculations. The 95% UCL value was used as the exposure point concentration for arsenic (1,413 mg/kg) and lead (976 mg/kg). The maximum concentrations of metals detected in the surface water samples were used as the exposure point concentrations for this screening-level risk assessment for surface water at the Spring Meadow Lake site. Table 5-13 presents the 95 % UCLs and

maximum total metal values in surface water used for the exposure point concentrations for the Spring Meadow Lake east arm.

The concentration of arsenic for the Montana Wildlife Center area ranged from 10 to 33,700 mg/kg, with a mean of 2,543 mg/kg and a 95% UCL value of 5,136 mg/kg. Concentrations of lead in the Montana Wildlife Center area ranged from 18 to 16,300 mg/kg, with an average of 1,563 mg/kg and a 95% UCL of 2,812 mg/kg. Fourteen samples (2 surface and 12 subsurface soil samples) were used in the calculations. The 95% UCL values used for the exposure point concentrations for the Montana Wildlife Center area are shown in Table 5-13.

TABLE 5-13
EXPOSURE POINT CONCENTRATIONS
SPRING MEADOW LAKE SITE

Site Area	Media	Arsenic	Lead
Spring Meadow Lake – East Arm Area Soils = 95% UCL Surface Water = Maximum concentration	Solid Matrix (mg/kg)	1,413	976
	Water (mg/L)	0.032	0.005 ^a
Montana Wildlife Center Soils = 95% UCL	Solid Matrix (mg/kg)	5,136	2,812

Notes:

95% UCL Upper 95th % confidence level

mg/kg Milligrams per kilogram

mg/L Milligrams per liter

^a Sample concentration from the October 2003 site investigation

5.5.3 Toxicity Assessment

The toxicity assessment phase evaluates the potential for COCs to cause adverse carcinogenic or noncarcinogenic effects in exposed populations. The most hazardous COCs identified at the Spring Meadow Lake site are arsenic and lead. Manganese is found at high concentrations at Spring Meadow Lake but is not considered as hazardous as arsenic and lead at this site because manganese is usually toxic only from inhalation or ingestion of fumes and dusts, which are not a primary concern for recreational use exposure at Spring Meadow Lake. The following sections summarize the potential adverse effects and dose-response relationships for arsenic and lead. The other metals at the site do not pose a significant risk to potential human receptors and were, therefore, excluded.

Arsenic

Arsenic is the twentieth most abundant element in the earth's crust and is present in virtually all living organisms. Freshwater supplies contain up to 1.4 mg/L of arsenic in certain areas of the United States and Canada. Seafood can contain significant concentrations of arsenic, ranging from 2 mg/kg for freshwater fish to 22 mg/kg for lobsters, most of which is organically (protein) bound. The average adult dietary intake of arsenic is between 0.025 and 0.033 milligrams per kilogram per day (mg/kg·d). This amount is nearly twice the level EPA considers to produce adverse health effects in humans (that is, the lowest observed adverse effects level [LOAEL] = 0.17 mg/L or 0.014 mg/kg·d). The largest source of human exposure to arsenic is arsenical pesticides that account for 80 percent of the industrial consumption of arsenic worldwide. However, other principal uses of arsenic include the manufacture of pharmaceuticals, glass, ceramic products, and metallurgy (Agency for Toxic Substances and Disease Registry [ATSDR] 1993a).

The Montana DEQ Remediation Division recently promulgated a generic action level for arsenic in surface soil of 40 mg/kg (MDEQ 2005). Arsenic occurs naturally in Montana soils at levels above both generic and Montana-specific risk-based concentrations. DEQ gathered data from 209 samples collected from unaffected (native) soils across Montana and calculated the 95% UCL of the mean of the data. The level of 40 mg/kg was selected as the generic action level for arsenic in Montana surface soils.

Arsenic (and arsenic compounds), especially organic arsenicals, are readily absorbed into the body after inhalation, ingestion, or dermal contact. When ingested, soluble arsenic compounds, including solutions, are almost completely absorbed through the gastrointestinal tract. Conversely, insoluble arsenic compounds are poorly absorbed, if at all. An orally administered dose of arsenic is distributed rapidly to virtually all tissue compartments (probably bound to protein), with the highest concentrations subsequently detected in the muscle, followed by the liver, hair, nails, and kidney; excretion by the kidney is almost complete within 6 days and accounts for over 90 percent of the dose. In liver tissue, trivalent arsenic (As^{+3}) is converted by microsomal enzyme systems and excreted in urine as multiple metabolites, including dimethylarsenic acid (50 percent), methyl arsenic acid (14 percent), pentavalent arsenic (8 percent), and trivalent arsenic (8 percent). Organo-arsenic compounds like those typically found in crab meat and other types of seafood are excreted essentially unchanged (ATSDR 1993a).

These “detoxification” processes effectively increase the molecular weight and polarity of the metal complex, thereby enhancing the rate of excretion in aqueous urine (half-life $[t_{1/2}] = 7$ hours). Like lead, mercury, and other heavy metals, arsenic is readily incorporated in fingernails, toenails, bone, and hair, providing an additional means of assessing historical exposure (ATSDR 1993a).

Symptoms of acute arsenic exposure include vomiting and diarrhea caused by severe gastrointestinal distress and general vascular collapse. The estimated lethal doses for humans are 60 milligrams of trivalent arsenic (As^{+3}) and 250 milligrams of pentavalent arsenic (As^{+5}). The most frequently noted and characteristic effects of chronic arsenic toxicity in humans include skin lesions, peripheral vascular disease, cardiovascular abnormalities, and peripheral neuropathy. However, the most significant toxic effect of chronic or prolonged low-level exposure to arsenic is carcinogenicity, including increases in the incidence of respiratory and skin cancers. For example, repeated epidemiological studies have found an increased incidence of skin and respiratory tract tumors in people exposed to arsenic fumes and dusts. Some studies have also reported increased bladder cancers. One study of elderly males in villages with arsenic-tainted drinking water showed a dose- and time-dependent response curve, with skin cancer rates as high as 26 percent in males exposed to water containing more than 0.6 mg/L arsenic. However, results of ingestion studies with animals have been generally equivocal (ATSDR 1993a).

Most reports of chronic arsenic toxicity have been in occupational settings from workers exposed to fumes and dusts, causing local irritation of the mucous membranes of the eyes and nose. Chronic toxicity is best diagnosed by measurement of concentrations in the hair or urine. For example, concentrations of arsenic in hair of normal persons are typically less than 1 mg/kg (average 0.5), whereas concentrations in subjects of chronic poisoning are often between 1 and 5 mg/kg, and can range as high as 47 mg/kg (ATSDR 1993a).

Given its systemic distribution, arsenic is readily transported across the placenta to fetal tissues, but teratogenicity (birth defects) and other reproductive effects have not been reported in laboratory animals at low to moderate parental dosages. However, chromosomal aberrations have been documented in humans exposed to industrial sources of arsenic, and select arsenic compounds have been found to be mutagenic in both *in vivo* and *in vitro* studies (ATSDR 1993a).

Arsenic is a Class A (that is, known) human carcinogen. Its oral slope factor is listed in EPA’s Integrated Risk Information System (IRIS) substance file (last updated April 10, 1998), as 1.5 mg/kg d. No dermal slope factor was available for arsenic when this report was written. However, a dermal slope factor of 20

times the oral slope factor has been derived and employed on the basis that 5 percent of an ingested dose is absorbed by the gastrointestinal tract (EPA 1989a). The oral reference dose (RfD) reported in IRIS (EPA 1998) for arsenic toxicity in humans is 0.0003 mg/kg/d based on a chronic exposure study that produced hyper-pigmentation, teratosis, and possible vascular complications. The confidence level reported for this oral RfD was "medium." Unfortunately, no direct RfD for arsenic is available for the inhalation or dermal exposure pathways. As above, a dermal RfD value equal to 5 percent of the oral RfD has been derived assuming that approximately 5 percent of the ingested arsenic will be absorbed by the gastrointestinal tract (EPA 1989a). No RfD was calculated for the inhalation pathway since there is no standard relationship between oral and inhalation RfDs for inorganic compounds (EPA 1989a). An uncertainty factor of three is deemed sufficient for the arsenic RfD to account for outlying groups or effects, including so-called "sensitive" individuals, potential reproductive impacts, and other toxicological data gaps (ATSDR 1993a).

Lead

Lead and inorganic lead compounds are found in a variety of commercial products and industrial materials, including paints, plastics, storage batteries, bearing alloys, insecticides, and ceramics. In addition, lead is found naturally occurring in western United States soil at an average concentration of about 17 mg/kg (Shacklette and Boerngen 1984).

Humans are in a state of positive lead balance from the day of birth, such that a relatively slow accumulation occurs until a total body burden of approximately 50 to 350 milligrams of lead exists by age 60. Normal adults have been shown to absorb approximately 5 percent of an oral dosage of various lead compounds, although absorption depends entirely on the individual and the nature of the lead compound in question. Research has shown that men typically have higher concentrations of lead in nearly all tissues than women, and further, that the developing fetus and adolescent children are the two most sensitive subpopulations (ATSDR 1993b).

More than 90 percent of absorbed lead is deposited in bone, primarily dense bone, with only minor amounts excreted in hair, nails, or urine. However, the average absorption of lead in children may be significantly higher than in adults (that is, as high as 50 percent). Inhalation studies have shown that about half the lead deposited in the alveoli of the lung is absorbed directly into the blood stream and that most of the dosage (90 to 95 percent) is subsequently deposited in skeletal bone, where the half-life is

estimated to be 7 to 10 years. Although the predominant elimination pathway for lead (and most heavy metals) is urine, the rate of urinary excretion is notably slow (ATSDR 1993b).

Lead has been shown to adversely affect many enzyme systems, but the overall health effects from lead exposure are typically related to elevated blood-lead concentrations that can result in a variety of toxicological effects, depending on the level of exposure. For example, the most noteworthy clinical indices of lead toxicity in humans are its effects on heme (blood) synthesis, resulting in erythrocyte anomalies, and imbalances of porphyrin, protoporphyrin, and aminolevulinic acid. Generally, a concentration of 40 micrograms per decaliter ($\mu\text{g dL}$) is considered the normal upper limit for blood lead, 99 percent of which is typically contained within erythrocytes (ATSDR 1993b).

The general symptoms of chronic lead poisoning include gastrointestinal disturbances, anemia, insomnia, weight loss, motor weakness, muscle paralysis, and nephropathy. For example, blood-lead concentrations higher than 40 $\mu\text{g dL}$ have been associated with central nervous system and kidney damage, as well as pernicious anemia. Concentrations on this order have also been associated with reproductive effects, miscarriage in pregnant woman, and sterility in males. Blood concentrations of 30 $\mu\text{g dL}$ and higher have been associated with defects in Vitamin D metabolism and with learning deficits in exposed children (ATSDR 1993b).

The effects of lead exposure at blood concentrations of 20 $\mu\text{g dL}$ and lower are more difficult to define. Some studies have reported increased blood pressure in males, starting at blood concentrations of about 10 $\mu\text{g dL}$. Low-level exposure to lead during early childhood can cause multiple effects, including impaired intellectual and neurobehavioral development. In fact, it appears that some of these effects, particularly changes in the levels of certain blood enzymes and impaired neurobehavioral development of children, may occur at blood-lead levels so low as to be essentially without a "threshold." Similar low-level exposures to lead during pregnancy have been shown to cause reduced birth weight and preterm births. This sensitivity to lead toxicity extends from the fetal stage to the cessation of growth after puberty. Studies of blood-lead concentrations in children of industrially exposed fathers revealed that as many as 42 percent of the children exhibited blood-lead concentrations greater than 30 $\mu\text{g dL}$ and more than 10 percent of the children exceeded 80 $\mu\text{g dL}$ as a result of lead carried home on contaminated clothing (ATSDR 1993b).

On the basis of bioassay results in rats and mice, EPA has classified lead as a Class B2 (that is, probable) human carcinogen. Controlled dosage studies in humans have produced renal tumors after dietary and subcutaneous exposures to soluble lead salts. However, dosages that typically induce cancer in humans are higher than are associated with other health effects of lead exposure, such as reproductive and developmental toxicity and increased blood pressure (ATSDR 1993b).

Unfortunately, no standard carcinogenic slope factors or RfDs are available for lead. Although the “uptake biokinetic” model is used to calculate the risk to children in a *residential* land-use scenario, the model cannot be used to calculate risks to adults or children in *recreational* exposure settings. A cancer slope factor or RfD must first be obtained or calculated to assess the recreational risks to the adult and child from lead. Using the uptake biokinetic model with standard residential assumptions, the maximum safe concentration of lead for noncancerous effects has been set at 400 mg/kg. Therefore, standard residential child exposure assumptions were combined with an exposure point concentration of 400 mg/kg to calculate oral and dermal RfDs. The RfD was then adjusted until the hazard quotient (HQ) was equal to 1.0. The dermal RfD was calculated to be 5 percent of the oral RfD assuming that approximately 5 percent of ingested lead is absorbed by the gastrointestinal tract (EPA 1989a). No RfD was calculated for inhalation since there is no standard relationship between inhalation and oral RfDs for inorganic compounds (EPA 1989a). Using these derivation methods, the oral RfD was set at 0.0026 mg/kg/d and the dermal RfD was calculated at 0.00013 mg/kg/d.

5.5.4 Risk Characterization

This section summarizes the results of the human health risk evaluation, which included a statistical analysis of data, an exposure assessment, a toxicity assessment, and a risk characterization. Based on current and potential future land use, children and adult recreational exposure scenarios and an on-site worker scenario were evaluated based on the reasonable maximum exposure (RME). The RME evaluation incorporates conservative exposure parameters, as described below. In addition, exposure point concentrations (EPCs) for the RME evaluation are the lesser of the maximum detected concentration or the 95% UCL. Cancer risks and noncancer hazard indices (HIs) are summarized in the following sections; supporting calculations for the risks and HIs are contained in the accompanying tables.

The estimated cancer risks for the recreational exposure scenarios are based on separate evaluations for children (weighted averages for children 0 to 18 years) and for adult receptors. The noncancer HI was calculated for both the child and adult recreational receptors (Appendix 5-C). The total HI estimated for the child receptor is greater than for the adult because the intake for children of each medium (such as soil) per unit body mass is higher (hence, noncancer HIs for a child resident are always higher than the noncancer HIs for an adult). The following sections describe the risk calculations and uncertainty associated with the risk calculations.

Risk Calculations

The carcinogenic and noncarcinogenic risks to potential human receptors from arsenic and lead in soil were evaluated for the Spring Meadow Lake site. Arsenic was evaluated using standard EPA risk assessment methodologies. Lead was evaluated using a LeadSpread approach because there is no reported allowable exposure for lead. Arsenic poses both carcinogenic and noncarcinogenic risks, while lead is considered only in the noncarcinogenic risk assessment. Tables that summarize the risk calculations are in Appendix 5-C. The exposure parameters for arsenic were derived from various EPA sources, as noted below. The child and adult recreational exposure scenarios were evaluated using the following exposure assumptions:

Recreational Child Exposure

- Exposure duration = 18 years (6 years for young child noncarcinogen)
- Exposure frequency = 20 days per year
- Body weight = 35 kilograms (weighted average); 15 for young child
- Averaging time carcinogenic exposure = 25,550 days
- Averaging time non-carcinogenic exposure = 2,190 days
- Ingestion rate = 133 milligrams soil per day (time-weighted average [TWA])
- Inhalation rate = 4.8 cubic meters per day (TWA)
- Particulate concentration = 0.00076 milligrams per cubic meter
- Surface area = 3,700 square centimeters per day (TWA)
- Adherence factor = 0.2 milligrams per square centimeter (TWA)

Recreational Adult Exposure

- Exposure duration = 24 years
- Exposure frequency = 20 days per year
- Body weight = 52 kilograms (TWA)
- Averaging time carcinogenic exposure = 25,550 days
- Averaging time non-carcinogenic exposure = 8,760 days
- Ingestion rate = 100 milligrams soil per day (TWA)

- Inhalation rate = 20 cubic meters per day (TWA)
- Particulate concentration = 0.00076 milligrams per cubic meter
- Surface area = 5,700 square centimeters per day (TWA)
- Adherence factor = 0.27 milligrams per square centimeter (TWA)

The risks for the on site worker exposure scenario was evaluated using the following exposure parameters:

- Exposure duration = 25 years
- Exposure frequency = 165 days per year (365 - November to February [120 days] vacation [15 days] – 2 days per week [65 days])
- Body weight = 70 kilograms
- Averaging time carcinogenic exposure = 25,550 days
- Averaging time non-carcinogenic exposure = 9,125 days
- Ingestion rate = 100 milligrams soil per day
- Inhalation rate = 20 cubic meters per day (TWA)
- Particulate concentration = 0.00076 milligrams per cubic meter
- Surface area = 5,700 square centimeters per day
- Adherence factor = 0.15 milligrams per square centimeter

Individual HQs and relative percent contributions to total risk for arsenic in soil for each exposure scenario are summarized in Table 5-14.

TABLE 5-14
RISK VALUES FOR ARSENIC IN SOIL
SPRING MEADOW LAKE SITE

Site Area	Exposure Scenario	Arsenic Risk Values for Soil	
		Carcinogenic	Noncarcinogenic HQ
Spring Meadow Lake – East Arm Area	Recreational Child	1.3 E-04	2.6
Spring Meadow Lake – East Arm Area	Recreational Adult	1.1 E-04	0.73
Montana Wildlife Center	On-site Adult Worker	2.2 E-03	14

Notes:

HQ Hazard Quotient (relative toxicity value for a single metal in a single medium)

EPA guidance on exposure levels that are considered protective of human health is presented to aid in interpreting the results of the risk assessment. EPA defined general remedial action goals for sites on the National Priorities List in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (Title 40 of the *Code of Federal Regulations* Part 300.430). The goals include a range for residual carcinogenic risk, which is “an excess upper-bound lifetime cancer risk to an individual of between 10^{-4} and 10^{-6} ,” or 1 in 10,000 to 1 in 1,000,000. The goals set out in the NCP are applied once a decision to remediate a site has been made. A more recent EPA directive (EPA 1991b) provides additional guidance on the role of the HHRA in supporting risk management decisions, and in particular, deciding whether remedial action is necessary. Specifically, the guidance states, “Where cumulative carcinogenic risk to an individual based on reasonable maximum exposure for both current and future land use is less than 10^{-4} , and the noncancer HQ is less than 1, action generally is not warranted unless there are adverse environmental impacts.” Nevertheless, all carcinogenic risks and noncarcinogenic hazards are presented to facilitate risk management decisions.

As can be seen in Table 5-13, in risk calculations for the Spring Meadow Lake site the child and adult recreational and on-site worker exposure scenarios resulted in carcinogenic risk values that were within or above the risk management range of 1×10^{-4} to 1×10^{-6} for carcinogens. The noncarcinogenic HQ exceeds the threshold value of 1 only for the child recreational user and the on-site worker. The east arm and the Montana Wildlife Center area contain arsenic at concentrations that pose potential risks to human health.

The risk from lead was evaluated qualitatively by comparing the 95% UCL of lead in site soils with a recreational soil lead value of 550 mg/kg and to EPA Region IX industrial soil PRG (750 mg/kg).

Table 5-15 lists the qualitative risk evaluation for lead under the adult and child recreational user and on-site worker exposure scenarios. Areas with elevated lead concentrations are located across the site, with the highest concentrations found around the former Stedman Foundry building area (TP-107).

Uncertainties in the Risk Calculations

Uncertainty in the risk values calculated can be created by a number of factors, including: (1) exclusion of exposure pathways from the risk calculation, (2) exclusion of potential hazardous constituents, (3) inaccurate land use and exposure values, (4) the accuracy of the toxicity values, and (5) the accuracy of the exposure point concentrations. Table 5-16 lists the relative effect of each of these sources of error on the risk values calculated. Each uncertainty factor is discussed below.

TABLE 5-15

**RISK VALUES FOR LEAD IN SOIL
SPRING MEADOW LAKE SITE**

Criterion (mg/kg)	Recreational	On Site Worker
	550	750
Number of Samples	32	14
Number Above Criteria	10	4
Maximum Concentration (mg/kg)	6,180	16,300
Minimum Concentration (mg/kg)	20	18
Mean Concentration (mg/kg)	631	1,563
RME Concentration (mg/kg)	976	2,812

Notes:

mg/kg Milligrams per kilogram

N/A Not applicable

TABLE 5-16

**SUMMARY OF UNCERTAINTIES FOR RISK ASSESSMENT
SPRING MEADOW LAKE SITE**

Source of Uncertainty	Probable Effect
Exclusion of exposure pathways from the risk calculation	Underestimate <1 OM
Exclusion of potentially hazardous constituents	Underestimate <1 OM
Inaccurate land use and exposure values	Overestimate up to 1 OM
Accuracy of the toxicity values	Overestimate up to 1 OM
Accuracy of the exposure point concentrations	Over- or under-estimate << 1 OM

Notes:

OM Order of Magnitude

- (1) **Exclusion of exposure pathways from the risk calculation.** The exclusion of exposure pathways from risk calculations because of data gaps or the lack of applicable toxicity values will cause an underestimation of potential risk. The total site risk is the sum of the individual risks posed by each pathway (for example, soil, sediment, surface water).
- (2) **Inaccurate land use and exposure values.** The exclusion of potentially hazardous constituents because field data are unreliable will result in the underestimation of risk. The total site risk is the sum of all risks from potentially hazardous constituents present in all media. The exclusion of contaminants from the risk calculations as a result of inferior data quality results in reduction of the calculated risk values. The amount of underestimation regarding risk posed by these metals is unknown, but is probably less than one order of magnitude.
- (3) **Accuracy of the toxicity values.** Conservative estimations surrounding land use and exposure assumptions will result in an overestimation of site risks. The land use assumptions were based on visual inspections of the site. All areas with the potential for recreational use by humans (east arm) were included in the recreational risk area. The exposure assumptions used in the risk assessment are standard values thought to be conservative. The amount of overestimation of risk because of these assumptions is unknown, but is not likely to exceed one order of magnitude.
- (4) **Accuracy of the exposure point concentrations.** The magnitude of toxicity values strongly affects the calculated risk value. However, the reference toxicity values used in the current risk assessment were conservative in nature, likely resulting in an overestimation of site risk. The methodology used to develop reference toxicity values assures that the value will overestimate rather than underestimate the potential risk. The toxicity values calculated during this risk assessment are also likely to be conservative since they are derived from conservative starting points using conservative assumptions. The amount of overestimation from the use of toxicity values is unknown, but should not exceed one order of magnitude.
- (5) **Exclusion of potentially hazardous constituents.** The accuracy of calculated exposure point concentrations is unknown. However, the calculated exposure point concentrations used in this risk assessment are likely to result in an underestimation of risk. Since a mean or average concentration of metals in soil was used in the risk assessment, there are many areas with above-average concentrations of metals. Thus, the risk to a receptor exposed to areas with higher metal concentrations would be underestimated. Depending on the metal in question, the risk posed may be greater or lesser than was estimated by the risk assessment.

5.5.5 Risk-Based Cleanup Goals

Risk-based cleanup goals are calculated to allow for the design and implementation of reclamation activities. Tables 5-14 and 5-15 show the risks for arsenic and lead for the child and adult recreational user and the on-site worker exposure scenarios for the Spring Meadow Lake. Table 5-17 lists the cleanup goals for lead and arsenic in soil for carcinogenic and noncarcinogenic risks for the recreational child and on-site worker land use scenarios.

TABLE 5-17

**RECREATIONAL RISK-BASED CLEANUP GOALS
SPRING MEADOW LAKE**

Exposure Scenario	Lead	Arsenic		
		Carcinogenic		Noncarcinogenic
		10-5	10-4	HQ = 1
Recreational child (mg/kg)	400 ^a	110	1,100	550
On-site Worker (mg/kg)	750	23	230	380

Notes:

a Recreational lead based on Residential PRG

mg/kg Milligrams per kilogram

10-5 1×10^{-5} Cancer risk10-4 1×10^{-4} Cancer risk

HQ Hazard quotient

5.5.6 Risk Characterization Summary

The risk values summarized for the Spring Meadow Lake in Tables 5-18 and 5-19 indicate that the site poses potential risks to children and adult recreational users and to the on-site workers at the Montana Wildlife Center. The calculated HQs can be used to determine whether human receptors are potentially exposed to harmful doses of site-related contaminants via the high-use recreational scenarios evaluated.

TABLE 5-18

**SUMMARY OF TOLERABLE AND PHYTOTOXIC SOIL
CONCENTRATIONS (mg/kg dry weight)
SPRING MEADOW LAKE SITE**

Element	Tolerable Soil Level (CH2M Hill 1987)	Phytotoxic Soil Concentrations (Kabata-Pendias and Pendias 1989)
Arsenic	50	15 to 50
Lead	25	100 to 400
Zinc	50	70 to 400

Notes:

mg/kg milligrams per kilogram

TABLE 5-19

**MAMMALIAN TOXICOLOGICAL DATA FOR INORGANIC METALS
SPRING MEADOW LAKE SITE**

Dose	Arsenic	Lead	Zinc
NOAEL ^a - Rat	3.2	0.05	55
LOAEL ^b - Rat	6.4	5	571
References	ATSDR 1993a	ATSDR 1993b; Eisler 1988b	Maita and others 1981
Lethal - Deer	34	N.A	N.A
Reference:	Eisler 1988a	N.A	N.A

Notes:

- ^a No Observed Adverse Effect Level (NOAEL)
^b Lowest Observed Adverse Effect Level (LOAEL)
 NA Not available
 ATSDR Agency for Toxic Substances and Disease Registry

All units are milligrams per kilogram per day (mg/kg/d)

Arsenic and lead were above criteria used for screening in the east arm. Eleven of the 32 samples collected during the RI from the east arm contained arsenic at concentrations above the 550 mg/kg level that equated to a HQ of 1.0. Soils with the elevated arsenic levels (above 550 mg/kg) were also the same materials that contained lead above 400 mg/kg in all cases except one sample (TP-155A). Using the risk-based cleanup levels for arsenic therefore would also remove the highest lead-contaminated soil.

The Montana Wildlife Center contains surface and subsurface materials with higher levels of arsenic and lead compared with the east arm. The more intensive use scenario for a typical on-site worker provides the rationale for removing materials to a more conservative (lower concentration) cleanup level. The arsenic carcinogenic point-of-departure (1 in 10,000 or 1 E-05) corresponds to a cleanup level of 23 mg/kg. The concentration of arsenic that corresponds to an HQ of 1.0 for noncarcinogens was 380 mg/kg. Twelve of the 14 Montana Wildlife Center samples contained arsenic at a concentration above 23 mg/kg, and two samples contained arsenic above 380 mg/kg. Using arsenic to define the material for cleanup at the Montana Wildlife Center would also remove the soil with the highest concentrations of lead.

The distribution of arsenic and lead in surface and subsurface materials at the east arm and the Montana Wildlife Center constitute probable adverse human health effects for children and adult recreational users and to on-site workers at the Montana Wildlife Center. Consequently, cleanup measures for the site are warranted.

5.6 ECOLOGICAL RISK ASSESSMENT

An ecological risk assessment was conducted for the Spring Meadow Lake site to evaluate potential impacts to the terrestrial plant communities and to aquatic organisms and their habitats. The ecological risk assessment was a qualitative screening-level ecological risk assessment (SLERA) because of the limited and indirect nature of the data available for the site. The assessment involved the initial identification of COCs, followed by development of an exposure assessment, an ecological effects assessment, and a risk characterization.

The SLERA for the Spring Meadow Lake site used several key federal guidance documents, including: (1) EPA's "Risk Assessment Guidance for Superfund: Volume II - Environmental Evaluation Manual" (EPA 1989b); (2) EPA's "Framework for Ecological Risk Assessment" (EPA 1992); (3) EPA's "Wildlife Exposure Factors Handbook" (EPA 1993b); and (4) "EPA's Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessment" (EPA 1994). The mill waste at the site may pose a potential risk not only to humans but also to plants and animals that come into contact with them. SLERAs exclude the potential for effects on people and domesticated species, such as livestock. However, the health of people and domesticated animals is inextricably linked to the quality of the environment shared with other species.

The SLERA estimates the effects of taking no action at the site and involves four steps: (1) identification of contaminants, ecological receptors, and ecological effects of concern; (2) an exposure assessment; (3) an ecological effects assessment; and (4) risk characterization. These four tasks are accomplished by evaluating available data and selecting contaminants, species, and exposure routes of concern, estimating exposure point concentrations and intakes, assessing the ecological toxicity of the COCs, and characterizing overall risk by integrating the results of the toxicity and exposure assessments.

Environmental contaminants at the Spring Meadow Lake site that could affect ecological receptors include high concentrations of metals in the mill-processing debris. The waste materials and vegetation in the area are easily accessible to wildlife and could result in significant ecological effects. The objective

of this SLERA is to estimate current and future effects of implementing the no-action alternative at the Spring Meadow Lake site.

5.6.1 Contaminants and Receptors of Concern

The purpose of this SLERA was to assess the potential for contact between ecological receptors and the COCs. The qualitative results of the SLERA may be used to evaluate the need for and the extent of the reclamation efforts. In addition, the SLERA is useful in identifying the exposure pathways and biological characterization of the site, which are important for the human health risk assessment.

Contaminants of Concern

To be considered a COC, the metal must be detected at the site; data must be available that meet QA/QC criteria; and the metal must be present at concentrations above background. The analytes that meet these requirements for soil are arsenic, lead, manganese, and zinc. The analytes that meet these criteria for surface water and groundwater are arsenic, manganese, and zinc. Even though manganese is found at high concentrations at the Spring Meadow Lake site, the exposure pathway for this metal to site ecological receptors is not complete. Therefore, manganese is discussed as a potential site contaminant, but was not included in the calculation for ecological risk.

Data tables in Section 5.3 summarize the detectable concentrations for metals in soils, sediment, surface water, and groundwater. The following toxicological data pertain to arsenic, lead, and zinc, the primary COCs identified in the SLERA.

Arsenic

Although arsenic is an essential nutrient and occurs naturally in the environment and in all organisms, it is also a teratogen and a “known” carcinogen that can traverse placental barriers and produce fetal death and malformations in many species of mammals (Eisler 1988a). Its bioavailability and toxicity are modified by many biotic and abiotic factors that include the physical and chemical forms of arsenic, the route of exposure, the dosage, and the species of affected organism. In general, inorganic arsenic compounds are more toxic than organic arsenic compounds (that is, arsenicals), and trivalent species (As III) are more toxic than pentavalent species (As V). Inorganic As (V) is the most common species in water (USDI

1998). Arsenic has been demonstrated to bioconcentrate, but not biomagnify, in certain organisms (Eisler 1988a).

Terrestrial plants accumulate arsenic by root uptake from the soil and by adsorption of airborne arsenic deposited on the leaves. Studies have shown that certain plant species can accumulate substantial levels (ATSDR 1993a). The effects of arsenic on mammals vary by species, exposure route or pathway, and the physical and chemical form of the arsenic. Many mammals can rapidly excrete ingested inorganic arsenic (Eisler 1988a). However, arsenic is distributed to most tissue compartments, including placental and fetal tissues.

In aquatic environments, adverse effects of arsenic have been reported for a wide range of concentrations in water, sediments, and diets (USDI 1998). Gilderhus (1966), Spehar and others (1980), Suter and Mabrey (1994), and USDI (1998) have all evaluated toxicological benchmarks for screening arsenic in plants, invertebrates, fish, birds, amphibians/reptiles, and mammals. A summary of the earlier reported biotic effects of arsenic was included in USDI (1998). Levels of arsenic in aquatic invertebrates are not well defined, but some individual organisms showed no adverse effects below a tissue level of 30 mg/kg dry weight (USDI 1998). Gilderhus concluded that growth of immature bluegills slowed to some degree when the whole-body arsenic was 1 to 3 parts per million (ppm; dry weight basis). Schmitt and Brumbaugh (1990) determined that a no-effect level for fish equaled 1.0 mg/kg (dry weight basis).

Lead

Lead has been known to be a common pollutant and a potent environmental poison capable of altering normal blood formation and nervous system functions of the human body (Eisler 1988b). When absorbed in excessive amounts, lead can have carcinogenic properties, impair reproduction and liver and thyroid function, and interfere with resistance to infectious disease (EPA 1984). Lead is toxic in most of its chemical forms and can be incorporated into the body via inhalation, ingestion, dermal absorption, and placental transfer. Lead is also a known mutagen and teratogen.

The fate of lead in soil and soil solutions is affected by a variety of factors, including precipitation of sparingly soluble forms of lead; formation of relatively stable organic-metal complexes or chelates with soil organic matter; the soil's pH, CEC, and organic matter content; and the amount of lead in the soil (ATSDR 1993b). Most forms of lead are retained rather strongly in soil; thus, very little tends to leach from the soil. Lead can be transported via erosion of soil particulates that contain lead, which can then be

deposited in surface waters (ATSDR 1993b). Lead is not an essential element for plants, and excessive amounts have been shown to inhibit growth (Eisler 1988b). The effects of lead on mammals can include growth retardation, delays in maturation, and reduced body weight.

Zinc

Zinc is found in fairly uniform concentrations in rocks and soils and may range from about 10 ppm to 120 ppm (Kabata-Pendias and Pendias 1989). Zinc is considered an essential nutrient for both plants and animals. Soluble forms of zinc are easily taken up by plants, particularly by the root systems. Zinc will commonly accumulate in the upper soil horizons during soil weathering processes. Zinc is not considered highly phytotoxic, but zinc toxicity is more prevalent in acidic soils. Several plant species and genotypes are known to have evolved a degree of tolerance to elevated levels of zinc in soils, and some species may accumulate large amounts of the metal without showing overt symptoms of toxicity. Chlorosis (seen mainly in newly developed leaves) and depressed plant growth are the common symptoms of zinc toxicity (Kabata-Pendias and Pendias 1989).

Ecological Receptors of Concern

A variety of aquatic invertebrates, fish, amphibians and reptiles, birds, and small mammals are part of the general food web for the Spring Meadow Lake site, and many more species could be included in a more extensive ecological assessment. This SLERA has identified three groups of ecological receptors that are potentially affected by chemical contamination at the Spring Meadow Lake site. The first group of potential receptors is the terrestrial plant communities. Plant communities are of concern because they represent the first trophic level in the food chain and are consumed by many higher trophic level animals.

The second group of potential ecological receptors is the terrestrial wildlife that may use the area as part of their home range, including mule deer. Tetra Tech personnel observed evidence of use by mule deer during the RI field investigation. Grazing by wildlife species at this site is of concern based on the potential that they may consume contaminated vegetation, soil, and evaporative salts. The only terrestrial wildlife receptors evaluated in a quantitative manner in this ecological risk assessment are deer. Deer are assumed to represent the highest level of exposure to site contaminants, and the effects to deer can apply to other potential receptors.

The third group of potential receptors is the aquatic community, specifically aquatic invertebrates and fish. Spring Meadow Lake has an array of aquatic invertebrates and microorganisms that support various fish populations. The fish are prey for several species of birds that have been observed in the vicinity, including great blue herons and osprey. In addition, recreational enthusiasts frequently fish at the Spring Meadow Lake site and consume the fish that have been caught. Human health could be indirectly affected by this group of ecological receptors.

Ecological Effects of Concern

One ecological effect observed is that vegetation in some areas (source areas) on site is sparse and lacking in species diversity. The lack of vegetation and diversity in these areas may be partially a result of toxic and inhibitory levels of metals in the plant root zone, along with other detrimental physical and chemical (infertility) properties of the soil. A second ecological effect of concern is the potential for deer and other wildlife to ingest contaminated vegetation, water, and evaporative salts that may form on the tailings materials deposited on the surface. The third ecological effect of concern is the potential biomagnification of metals in the aquatic habitat through uptake of metals by plants and aquatic invertebrates and their consumption by fish in Spring Meadow Lake.

5.6.2 Exposure Assessment

The exposure point concentrations for the recreational and worker areas listed in Table 5-16 were used for the exposure point concentrations for ingestion by deer and phytotoxicity. Exposure point concentrations used for this SLERA (see Table 5-16) are the upper 95th percentile confidence limit of all surface soil and surface water samples collected at the Spring Meadow Lake site. Aquatic life was evaluated using data for water sample SW-203 and sediment sample SD-208. Sample SW-203 was collected from the east arm, and sample SD-208 was collected from the southern end of Spring Meadow Lake. Additionally, DEQ and FWP collected samples of aquatic invertebrates and two fish species to evaluate the potential for sublethal levels of metals to accumulate in the invertebrates and fish. The ingestion of water by deer was evaluated using data from sample SW-203.

The three exposure scenarios discussed below were used to assess ecological risk. However, the only scenario that involved the calculation of a dosage was one in which deer ingest contaminated soil, water, or salt. Contaminant criteria and toxicological indices used to assess both contamination and risk for the exposure scenarios were compiled from the following primary documents:

- Terrestrial plant communities: Gough and others 1979; Shacklette and Boerngen 1984; Kabata-Pendias and Pendias 1989; CH2M Hill 1987
- Terrestrial wildlife: Eisler 1988a and b; ATSDR 1993a and b; EPA 1993; Beyer and others 1994
- Aquatic life: Eisler 1988a and b; Long and Morgan 1991; USDI 1998, Tetra Tech 1996

Plant - Phytotoxicity Scenario

This scenario involves the limited ability of various plant species to grow in soils or mine wastes that contain high concentrations of arsenic, lead, and zinc. Plant sensitivity to certain arsenic compounds is so great that these compounds were used as herbicides for many years. Phytotoxic criteria reported in the literature for total arsenic in soils ranged from 15 to 50 mg/kg; the 50 mg/kg hazard level was considered appropriate for the Helena Valley, Montana (CH2M Hill 1987). Lead is also considered toxic to plants. Numerous phytotoxic concentrations are reported in the literature and generally range from 100 mg/kg (Kabata-Pendias and Pendias 1989) to 1,000 mg/kg (John and Van Laerhoven 1972, CH2M Hill 1987).

Deer Ingestion Scenario

Estimates of total intake dosage for deer are based on reported literature values and the following assumptions: (1) the sparsely vegetated areas do not provide deer habitat; (2) native vegetation is growing across most areas of the mill-processing site and would be available to deer that graze in the area; and (3) the average weight of an individual adult deer is 68.04 kilograms (150 pounds).

Contaminated Soil and Salt Intake

The daily salt uptake for deer is based on data in "Elk of North America" (USDA 1995), which reported a range of 1 to 11 pounds (average 6 pounds) in 1 month for a herd of 50 to 75 elk (average 63 head). Assuming deer require 50 percent of the volume of salt required by elk, a median exposure (non-conservative) approach would equate to an average salt use of 3 pounds per month. Using the average

herd size of 63, the average individual salt uptake would equal 0.0016 pounds per day (lbs day), or 0.00072 kilograms per day (kg day). Beyer and others (1994) estimated that soil ingestion accounts for less than 2 percent of the average Wyoming mule deer's diet of 1.39 kg day of vegetation and would equal 0.0278 kg day of soil. The arithmetic average concentrations of metals for the surface soils across the smelter site were used for both the salt and soil levels since these were the highest values calculated.

Metals in Vegetation Intake

Beyer and others (1994) estimated that an average mule deer ingests 1.39 kg of vegetation per day in summer. No samples of vegetation were collected for analysis during the RI. The concentrations of arsenic (50 ppm) and lead (25 ppm) used in this calculation were the tolerable levels in vegetation (lowest phytotoxic tissue levels) from the East Helena assessment (CH2M Hill 1987). The metal-contaminated areas at the Spring Meadow Lake site cover 20 acres. This area would represent 6 percent of an estimated average mule deer's home range of 90 to 600 acres (average of 345 acres; Beyer and others 1994).

Aquatic Life Scenario

This scenario involves the limited ability of aquatic organisms to survive in waters that have been contaminated with mining wastes, specifically metals. The toxicity of metals to aquatic organisms depends on the concentration of the metals in the surface water and sediment as well as other conditions, such as water hardness, temperature, and pH.

Arsenic

Arsenic can be lethal to fish and insects and has been found to impair reproduction at low concentrations. Although it is known to bioconcentrate, arsenic has not been found to biomagnify in the food chain (Eisler 1988a; Long and Morgan 1991). The concentrations of arsenic in water are normally less than 10 micrograms per liter ($\mu\text{g/L}$) (Eisler 1988a), and approximately 1 mg/kg (dry weight basis) is reported to be a no-effect level for freshwater fish (Schmitt and Brumbaugh 1990). Arsenic levels in sediment range from 8.2 mg/kg (dry weight basis) or less as the no adverse effects level, to a concentration of 70 mg/kg (dry weight basis) or higher as a toxicity threshold (Long and others 1995).

Lead

Lead concentrations have been shown to affect early life stages of aquatic macrophytes, especially in soft water at warmer temperatures. Nonlethal effects of lead on fish include excess mucus formation that interferes with respiration, spinal curvature, damage to organs, and reduced swimming ability. Lead is only minimally biomagnified in the food chain (Eisler 1988b).

Zinc

Although zinc is an essential nutrient to aquatic biota, toxic effects at high concentrations can include mortality, reduced growth, and inhibited reproduction. Embryos and juveniles have been found to be most sensitive to the effects of zinc. In addition, the effects of zinc on aquatic organisms are increased by the presence of other metals, such as cadmium and mercury.

5.6.3 Ecological Effects Assessment

The effects of the COCs at this site are described in several literature sources and are not repeated here. No site-specific toxicity tests were performed to support this SLERA. Only existing and proposed toxicity-based criteria and standards were used for this SLERA. The following sections detail the specific standards and data that were used for comparison to the analytical results of the RI field sampling investigation.

Plant - Phytotoxicity Scenario

A summary of the phytotoxicity for selected metals of concern (Kabata-Pendias and Pendias 1989) is provided in Table 5-17. These concentrations were used for comparison to mean concentrations of metals in mill waste. The availability of contaminants to plants and the potential for plant toxicity depends on many factors, including soil pH, soil texture, nutrients, and plant species.

Deer Ingestion Scenario

Adverse effects data for test animals were obtained from the ATSDR toxicological profiles (1993a, 1993b), and from other literature sources (Eisler 1988a, 1988b). The data consist of dose (intake) levels that either cause no observed adverse effects (NOAEL) or the lowest dose observed to cause an adverse

effect (the LOAEL) in laboratory animals. The use of effects data for other species introduces an uncertainty factor to the assessment; however, effects data for all metals are not available for the species of concern (deer). The lethal arsenic dose of 34 (mg kg d) for deer (Eisler 1988a) is also included. Data for laboratory animals (primarily rats) have been adjusted only for increased body weight. These data are listed in Table 5-18.

Aquatic Life Scenario

Montana water quality standards were used for comparison of analytical data from the Spring Meadow Lake water samples. Analytical results were adjusted for conditions such as water hardness, temperature, and pH, which can affect the toxicity of metals to aquatic organisms in surface water bodies. Montana water quality standards for aquatic life are presented in Table 5-20. Concentrations of arsenic in samples of aquatic invertebrates and bass and pumpkinseed fish were generally compared with reported screening levels in the literature (USDI 1998).

5.6.4 Risk Characterization and Summary

This section combines the ecological exposure estimates and concentrations presented in Section 5.6.2 and the ecological effects data presented in Section 5.6.3 to provide a screening-level estimate of potential adverse ecological impacts for the scenarios evaluated. This screening-level estimate was achieved by generating "ecological impact quotients" (EQ) analogous to the hazard quotients calculated for human exposures to noncarcinogens. EQs were calculated for each COC by exposure scenario or receptor type and are summarized in Table 5-21. Contaminant-specific EQs were generated by dividing the intake estimate or concentration by available ecological effect values or concentrations. Tables that summarize the risk calculations are found in Appendix 5-C. As with hazard indexes, if EQs are less than 1, adverse ecological impacts are not expected at the Spring Meadow Lake site.

TABLE 5-20
MONTANA SURFACE WATER QUALITY
AQUATIC LIFE STANDARDS (µg/L)

Metal	Acute Toxicity	Chronic Toxicity
Antimony (Sb)	88 ^a	30 ^a
Arsenic (As) – inorganic	340	150
Barium (Ba)	1,000 ^b	--
Cadmium (Cd)	1.05 ^c	0.16 ^c
Chromium (as Cr ³⁺)	1.804 ^c	86 ^c
Chromium (as Cr ⁶⁺)	16	11
Cobalt (Co)	--	--
Copper (Cu)	7.3 ^c	5.2 ^c
Cyanide (CN) – total	22	5.2
Iron (Fe)	--	1,000
Lead (Pb)	82 ^a	3.2 ^d
Manganese	50 ^b	--
Mercury (Hg) – total	1.7	0.91
Nickel (Ni)	261 ^c	29 ^c
Zinc (Zn)	67 ^c	67 ^c

Notes:

- ^a U.S. EPA (1986) criteria used since the contaminant is not included in Montana standards.
- ^b Ambient water quality standards for protection of human health through consumption of fish.
- ^c At 50 mg/L hardness.
- ^d At 100 mg/L hardness.
- Standard has not been adopted, or information is currently unavailable.

Reference: Montana Department of Environmental Quality (2001). Montana Numeric Water Quality Standards (Circular WQB-7), Water Quality Division, Helena, Montana.

TABLE 5-21
ECOLOGICAL IMPACT QUOTIENTS
SPRING MEADOW LAKE SITE

Receptor	Arsenic	Lead	Zinc	Total EQ By Receptor
Plant Phytotoxicity	7.46 (65)	1.30 (11)	2.72 (24)	11.48 (100)
Deer Ingestion	0.00 (0)	1.74 (100)	0.00 (0)	1.74 (100)
Aquatic Life – Surface Water	0.09 (43)	0.04 (19)	0.08 (38)	0.21 (100)
Aquatic Life – Sediment	1.29 (20)	2.90 (45)	2.29 (35)	6.48 (100)
TOTAL EQ BY COC	8.84 (44)	5.97 (30)	5.09 (26)	19.91 (100)

Notes:

- () Percent contribution to total receptor EQ.
- EQ Ecological Impact Quotient (relative toxicity value for a single metal in a single medium)
- NA Not applicable
- COC Contaminant of concern
- < Less than

Plant - Phytotoxicity Scenario

Maximum concentrations of metals collected from the source area at the Spring Meadow Lake site were compared with high values of the range of plant phytotoxicity derived from the literature. One limitation of this comparison is that the phytotoxicity ranges are not species-specific; instead, they represent toxicity to species that may or may not be present at the Spring Meadow Lake site. Additionally, other physical characteristics of the waste materials may create microenvironments that limit growth and survival of terrestrial plants directly or in combination with substrate toxicity.

Mill waste materials are likely to contain elevated concentrations of metals, low organic content, and limited nutrients, and may harden enough to resist root penetration. The results of the EQ calculations for this scenario are presented in Table 5-21. The EQs calculated for plant phytotoxicity at the Spring Meadow Lake site exceeded 1.0 for arsenic, lead, and zinc. The non-conservative assumption of using the high end of the phytotoxicity range to derive the EQs may underestimate the potential phytotoxic effect to some plant communities. However, several other factors in addition to phytotoxicity combine to adversely affect plant establishment and successful reestablishment on waste materials. In addition, the maximum concentrations of metals in soil were used as the plant dosage value in the EQ calculation, presenting the likelihood of an overly conservative EQ.

Deer Ingestion Scenario

Estimated ingestion doses for deer were compared with the higher of the literature-derived toxicological effect levels (that is, the LOAEL). The contaminant-specific EQs were generated by dividing the total intake estimates by the toxicological effects values. Again, the comparison is limited because effects data for other species (rat) were used that were adjusted only for increased body weight. The species used in the toxicological studies may have been more or less susceptible to the contaminant in question than are deer. The results of the EQ calculations for this scenario are also presented in Table 5-21.

The EQs calculated for the deer ingestion scenario exceeded 1.0 for lead only. This EQ indicates a potential risk to deer and other wildlife as a result of lead concentrations in surface soils.

The assumptions used to derive the uptake dose and the comparison to toxicity in rats may incorrectly estimate the actual average contaminant intake for deer. This potential for an adverse effect can be extended to other wildlife that may also use the area as a source for food and salt.

Aquatic Life Scenario

Maximum concentrations in surface water, sediment, aquatic invertebrates, and fish collected from the Spring Meadow Lake site were compared with acute aquatic water quality criteria and other toxicity screening levels derived from Long and Morgan (1991) and USDI (1998). The presence and persistence of metals in the sediments and near-shore soils may affect the aquatic life in Spring Meadow Lake. The results of the EQ calculations for this scenario are presented in Table 5-21.

Information presented in Table 5-21 indicates that the potential exists for adverse ecological impacts of sediment and near-shore soils to aquatic life communities at the Spring Meadow Lake site. However, the levels of arsenic in aquatic invertebrates and fish samples collected by DEQ and FWP were below the USDI (1998) and other reported screening levels (Schmitt and Brumbaugh 1990). The EQs for sediment exceeded 1.0 for arsenic, lead, and zinc. The EQs for surface water were less than 1.0 for all three metals.

Risk Characterization Summary

The calculated EQs can be used to determine whether ecological receptors are potentially exposed to harmful dosages of site-related contaminants via the three ecological scenarios evaluated. The EQs calculated for the Spring Meadow Lake site indicate that arsenic is the greatest overall risk driver for the site, with an EQ of 8.84. The risk posed by arsenic is split among plant toxicity (EQ = 7.46), aquatic life-surface water (EQ = 0.09), and aquatic life-sediment (EQ = 1.29). Arsenic poses virtually all (100 percent) of the risk to plants. Lead (EQ = 5.97) poses a significant risk to aquatic organisms through sediments (EQ = 2.90), to deer through ingestion (EQ = 1.74), and to plants (EQ = 1.30). Zinc (EQ = 5.09) poses a threat to aquatic organisms in sediments (EQ = 2.29) and to deer (EQ = 2.72).

Collectively, these calculated EQs and qualitative observations demonstrate that contaminants at the site constitute probable adverse ecological effects for plants, deer, and aquatic life at the Spring Meadow Lake site, justifying additional baseline risk assessment and cleanup measures.

5.7 SUMMARY AND CONCLUSION

The Spring Meadow Lake Site includes two main areas: the east arm and the Montana Wildlife Center. Both sites contain mill processing wastes and metal-contaminated soils at concentrations above the recommended cleanup levels. The nature and extent of the mill process wastes, the potential impacts to

human health, and the potential impacts to the environment are summarized below. Specific findings related to potential environmental impacts and risks to ecological receptors have not been derived. Additional sampling and analysis (baseline ecological risk assessment) may be needed to establish that a complete exposure pathway exists for site receptors (aquatic amphibians, reptiles, and fish) to be exposed and harmed by the site contaminants. Removal or isolation of the mill process wastes and associated contaminated materials would minimize potential risks to site workers, recreational users, and ecological receptors.

A screening-level human health risk assessment was conducted for the Spring Meadow Lake site as part of the RI performed in spring 2005. The risk assessment was conducted using current guidance set forth by EPA (1989a) and was updated to reflect the recreational use for Spring Meadow Lake east arm and for on-site workers for the Montana Wildlife Center. Conservative risk-based cleanup levels for arsenic and lead were used for the recreational and on-site worker scenarios. Elevated concentrations of lead were rarely found without a corresponding elevated level of arsenic. Therefore, any removal activities that focus on cleaning up arsenic above the risk-based cleanup level will also address the lead contamination.

5.7.1 East Arm Area

The mill process wastes and contaminated soils are found on or near the surface (upper 4 feet) in the east arm. Characterization efforts identified the contaminated materials with elevated concentrations of arsenic (maximum of 10,400 mg/kg) and lead (maximum of 6,180 mg/kg). Recommended removal depths have been selected based on potential risks to humans and the environment. Contaminated mill process waste materials deposited in the east arm have likely eroded into the lower ponded areas (actual Spring Meadow Lake east arm), where sediments and shoreline materials were found with elevated levels of arsenic (maximum of 2,130 mg/kg) and lead (maximum of 1,480 mg/kg). The contaminated sediments and shoreline materials are not completely characterized but have the potential to cause ecological impacts in the east arm. The total volume of surface, subsurface, and shoreline contaminated materials with metals about the recommended cleanup levels in the east arm is estimated at between 15,000 and 20,000 cubic yards.

Surface water samples were collected from 15 locations in Spring Meadow Lake. Arsenic and manganese were found to be elevated above Montana water quality standards (WQB-7) in samples collected from the southern east arm and the south end of Spring Meadow Lake (near the wooden foot bridge). Concentrations of metals in surface water are likely attributed to dissolution from the metal-contaminated

sediment and shoreline materials, rather than from groundwater. No metals were found to be elevated in samples from monitoring well MW-02.

5.7.2 Montana Wildlife Center

The Montana Wildlife Center area contains mill process wastes (primarily floatation tailings and manganese mill concentrates) at surface and subsurface locations at this site. An earthen sump (pit) was found to contain mill tailings to a depth greater than 18 feet (the maximum reach of the backhoe bucket) in one location near the east side of the former mill building (burned down and demolished). Test pits and analytical results revealed contaminated mill tailings and other wastes with elevated concentrations of metals to depths generally less than 5 feet below ground surface at other locations at the Montana Wildlife Center. Most of the areas with contaminated subsurface materials have been covered with gravel or with fill materials. Metal salt deposits are visible on the surface in areas where the surface gravel layer or fill material is thin. Characterization efforts revealed contaminated wastes along the east, south, and west sides of the former mill building. The total volume of contaminated materials in the surface and subsurface at the Montana Wildlife Center is estimated at between 10,000 and 15,000 cubic yards. The volumes of metal-contaminated surface and subsurface soils were estimated using a topographic contour map, along with known and interpolated depths of metal contamination across the Spring Meadow Lake site.

Elevated concentrations of arsenic and manganese were detected in the groundwater along the northern edge of the Montana Wildlife Center (MW-01). Groundwater at this location is likely contaminated from the subsurface tailings at this site.

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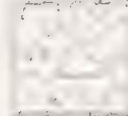
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APPENDIX 5-A
FIELD LOGBOOK

Montana Silver Smelter

5127 N. 1st St.
Helena, MT 59601



ALL-WEATHER
National Line
1-800-255-2552



Tetra Tech EM Inc.

6th & Last Chance Gulch, Suite 612 ♦ Helena, MT 59601

Spring Meadow Lake
Site - PA (back)
(half)

June 2004

RI - April 2005

SPRING MEADOW LAKE SITE

APRIL 8, 2005 (FRIDAY)

cool (40°F), cloudy, + windy

11:00pm Meeting City of Helena

Utilities & ELM Utility Locators

City of Helena representatives

present: Rick, Nathan, Branson

search: 447-1570 Rick or Bill

work: 447-1567 Branson or Rick

ELM Representative: ~~Tim~~ Jason
409-9502

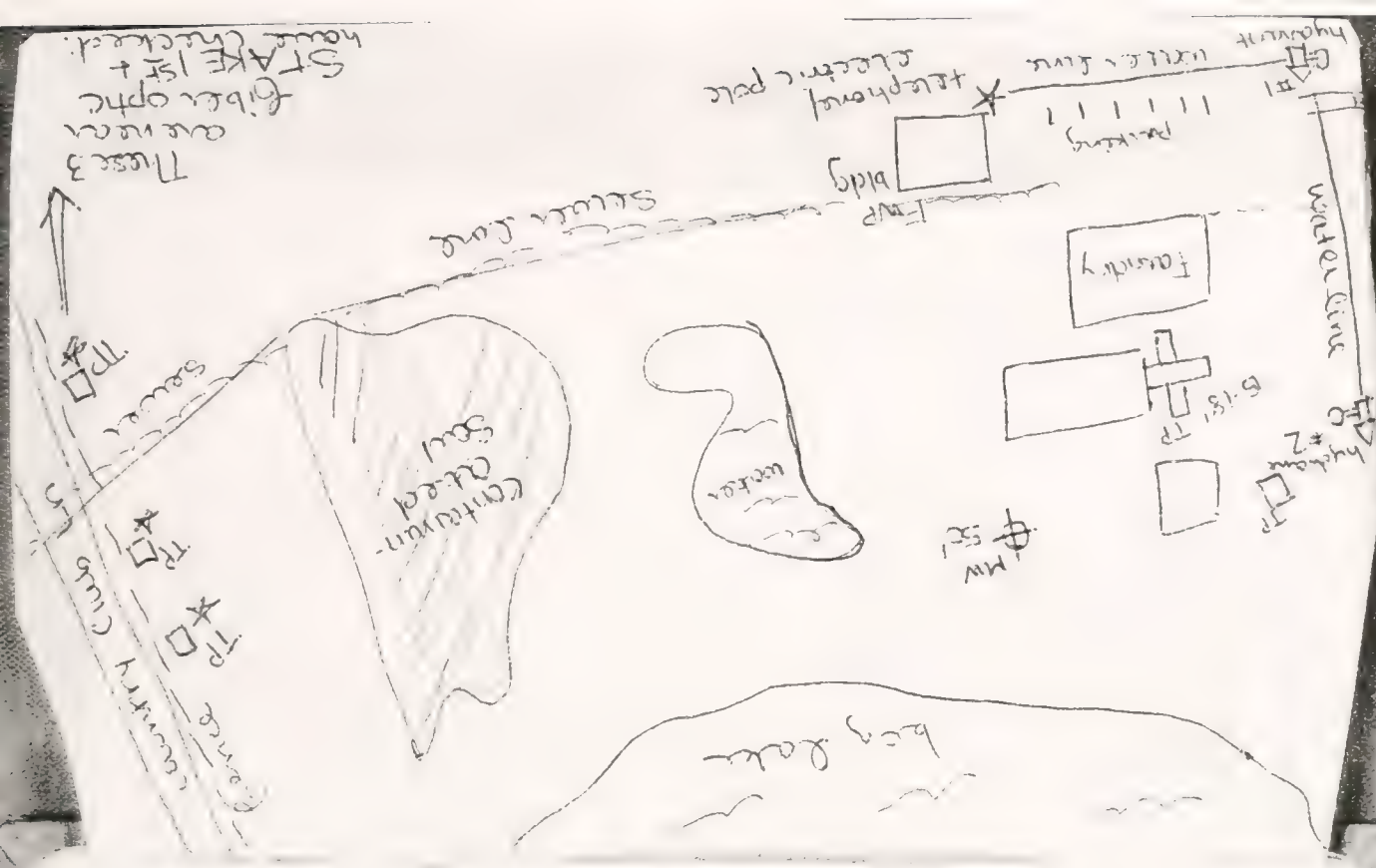
Water lines water line runs
from electrical pole near FWP bldg
(above) W along fence line to a
hydrant. It then runs N (slight NW)
across parking area to another
hydrant ~50m (2nd hydrant is
within fenced area enclosing old
stone bldg on the W end of old
bldg). * Should be fine for water
& utilities for 15-18' backhoe pits
& 50' down monitoring (1111)

4/8/05

Sewer Lines: Main line runs from parking area E to large contaminated area boundary (as determined in previous sampling) & heads NE toward Country Club Ln (toward houses on E side of road). Manhole covers should be staked & apparent. Check for these when putting in manhole; well. There is just the 1 main line; no branching sewer lines.

* ELM Utility Concern - Fiber Optic Lines near the fence by Country Club Ln. 3 of the backbone pits may be too close (ELM will need to supervise digging within 20' of these lines). Potential pit sites need to be staked - Jovan will return once staked & make sure they are 20 ft away from optic cables.

* No info provided on gas lines.



Craig Marx (SML Per Super) 495-3270

4-11-05 Monday c/w
Jerm (50°F)

0730 called O'Keefe drilling (Butte)

Dave Crowley to depart Butte 0900,
meet at SML 1200-1230.

1230 O'Keefe on site SML mob to
MW-02 at SE arm of lake, set up
ready to drill 1315.

Driller: Dave Crowley Helper: Marcus Crowley

Rig: Mobile Drill 3-61 on Ford F-900

1345 Drilled to 25', water level approx. 11.6'

1410 Drilled to 30' T.D., To screen B65

30-20' (.020 slot PVC 2" screen) 10' black iron

1430 Screen installed, pointed end cap
- all cuttings brown silica sand, 1-2" rounded
to subrounded gravels

- no split-spoon samples obtained

1515 10-20 colored silica sand to 7.9' bgs

(14 Bgs) Bentonite 7.9-1.0 bgs

sand 1-surface - bentonite chips 2'

up in casing - stick-up completion

1540 Pre-development SWL = 14.4 BTO PVC

stickup = 2.3' TOPVC

1550 Move off of MW-02, mob to MW-01

inside FWP Wildlife Rehab Unit

1610 Spud MW-01 ± 150' E of smaller of two

old stone buildings at MT FWP Wildlife Rehab
Unit.

4-11-05 (cont.)

1625 - Drilled to 25', water at 23.9

1645 - EOD - 30' T.D., to allow well
to stand overnight and construct
4-12 A.M.

Rob Mahr - Olympus Tech.
backhoe operator

4-12-05 Tuesday clear-calm
0800 on-site SML FWP wildlife ctr.
0830 Gate unlocked to provide access to
rig in FWP wildlife ctr. yard.
0900 Begin sand pack - 30' T.D. mud-01
install .020 2" PVC screen 30-10' bgs
(20')
1030 Complete construction - concrete apron
at base of stick-up
1100 SWL 23.18
TP. 32.55
2.1 stickup
1130 off-site
MW-01 at
MT Wildlife Rehab
ctr.

4-18-05 Monday
0900 Set-up on TP-151 on NE side SML
TP-151 0900
0-6" depth = TP-151
native soil in low area east
side of regraded reject
sand.
veg = Western wheat grass, Meloff
Woods rose
0-4" = dark brown SL A-horizon
4-12" " " SL A-B
10-18" light brown SL B-C horizon

TP-152 0920
Area on top of regraded sand/
reject sand. Poor veg on area
but probably due to sand - not
infect. Veg = ~~Horsetail~~, Arley, Agda,
Agsm, stee Rowo "A"
0-4" - dark brown SL "A" maybe
4-8" - sand-bogged, w/
black lenses
8" + more sand
Sample 0-8" = TP-152

TP-153 0931

Area = well vegetated w' grasses
& shrubs. Hg sm, fescue, S⁺ co,
Sym alb, small forbs.

TP-153 A 0931

0-6" brown fine sandy loam
some org. matter & fine roots

TP-153 B 0935

18-24" sand w/ black stringers
probably natural but?

TP-154 A 0945

North end of east arm
veg is good
smooth brown
WoRo, Degraded

Bridge

TP-154 A 0945

8-18" Dark clayey sand
orange brown tan
mottled - Non-native fill

4-5' burnt wood debris
fill from surface to
about 5' bgs

TP 154 B 0952

5-6'
native sandy gravels,
water table at about 4'

TP-155

55' SW of old TP-122

TP-155 A 0-4"

Dark brown loamy sand
appears to be impacted by
surface deposit of Mn

TP-155 B 18-24"
matting gravelly sand
light brown, moist
No water in pit at 2'

TP-156 - In low area SW of
largest cottonwood tree.
Pure fine sand some darker
layer on surface from OM
No dark lens

TP-156 A 10"-12" 1025
light brown sand

Buried "pail" on surface
at $\approx$ 3' bgs

TP-156 B 36-47" 1030
Buried layer may have some Mn
but

TP-157 + 4-6" 1045

- has to brown loamy "B" horizon sandy
soil, low organics, root mottles,
no dark sands noted

TP-157 B 24-36" 1050

- has/brown well sorted med. gr. sands
with lesser org-brown FeO stained
clay stringers - no dk sands noted

TP 158

34 barb-wire fence next to RR track
About 15' west of fence
Veg. - poor weedy, Bote, Meoff,

TP-158 A 1100

6-9" bgs - dark brown/black
sand layer sampled
- Mn-impacted layer may be
12-15' deep.

TP-158 B 1105

28-32" bgs - light br. gravelly
sand - probably clean.

TP-159

1115

cut 25' w' of fence. Black layer is down 4-6". Fine (any sand layer on top - not native. Veg as mod. = St co, rather thick some Agsm.
Dro c's below - native
No sample taken from submounds

TP-159/1

4-6" Sample taken from black lens.

TP-160 -

In middle of flats
Veg = mostly Agsm, others St co
H₂O. On edge of more obvious impacted area. Small mounds around = sand pile
TP-160/H 1125

4-6" black dump w/ orange mud - probably contained

Native gravels below - pit dug to B⁺ feet. No sample collected.

TP-161

In cut on east-side of east arm. Veg = poor - Dist Br. Agsm, Br⁺te, some open sprigs. Looks like g (bar but).

TP-161/H

1140

0-6" composite. Dark brown sandy loam. Some small dark lenses but not obvious Mn layer.

TP-162 A

1154

0-2" dark brown surface layer - below = light brown sand w/ some small gravels.

TP-162 B

30-40"

clay layer on top of old buried soil - light brown/yellow clay to "

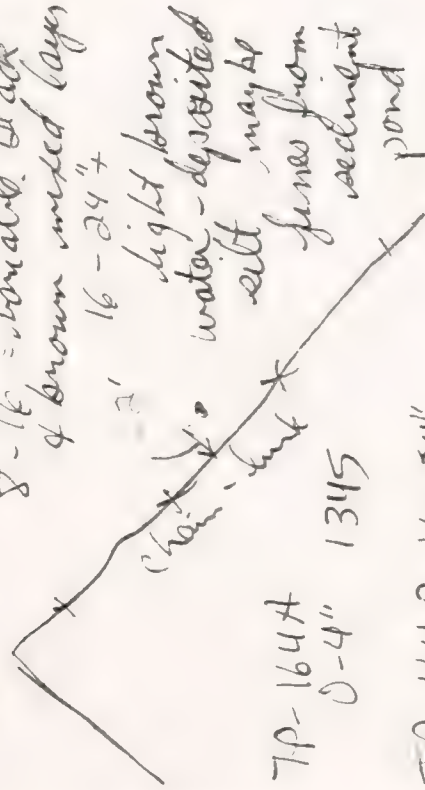
TP-163A 1230

0-6
Native soil - no obvious
cont. variation.
Ve. = Sym Hib, Hgs, m,

TP-164

- Open area - Saltgrass - 10.20

0-5 - dark brown/black
silty
8-16 - variable black
& brown mixed layers
16-24"



TP-164A

0-4" 1345

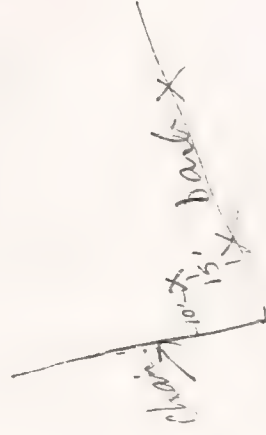
TP-164B 16-24"

1349

Native soils at 3'

TP-165

On small hill by barbed wire
& chain-link fence.
veg = meadow Hgs, but no
plants + ribs
TP-165 11 4-6" 1402

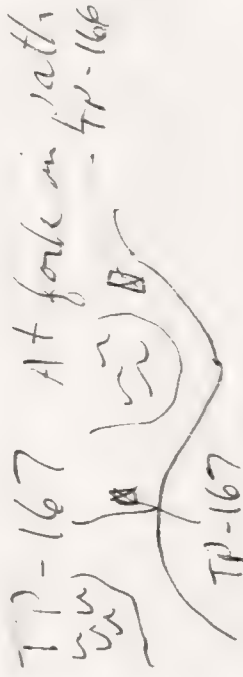


TP-166

By wooden bench at SE end
of east arm

8-10" black

TP-166 A	1420	0-4"
TP-166 B	1425	12-18"

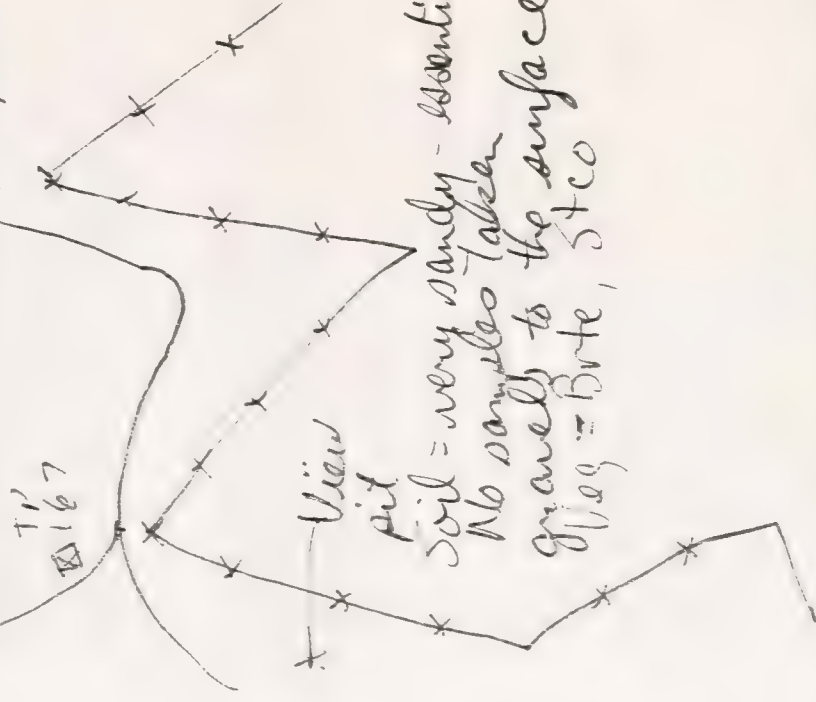


veg on surface = Dist Str. Tufted hair

willows
Some mill tailings (stringer)
from 15-17" sample
collected from 14-20"
Black tail all around
TP-167 A 14-20" 1445
TP-167 B 22-24" 1450

Black & tail from 0-20"
Below grey tan sands with lot
of cobbles
1450 - TP-167 B 22-24"

Test pit - (View only)

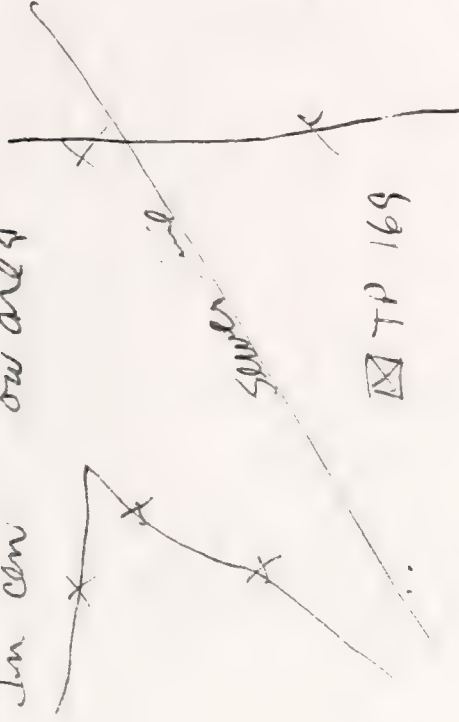


TP-168A 2-6" 1525
 Black (possibly asphalt) in
 far SE corner of chain-link
 compound
 Fine sand on top = poor veg
 Knapweed, baby's breath, Brte.

TP-168B 1530 18-24"
 Med to coarse-grained silica
 sand, below black

TP-168C 1545 3-5'
 Tan bedded silts & c. 1/8"
 and fines in S & G. many
 days, but?

TP-169
 In can
 own area



0-6' Dark br/black sandy loam
 1" coarse frag - not fine
 Aln tails

6-18 - bedded dark brown/light
 brown sandy loam/loamy sand
 implaced - not native
 18"-54" light brown sandy fill.
 Native gravels at 4.5-5

TP-169A	1555	0-6"
TP-169B	1600	6-18"

4-19-05 Tuesday overcast
 0830 on-site SML, waiting for FWP
 to open gate to Wildlife Rehab ctr.
 0915 Gate open
 0930 Begin excavation in center of
 lot between stone buildings FWP Wildlife
 Rehab. ctr.

TP-170

170A - 9:47 4'-6"

- light tan to brown unsorted sandy
 rounded to subrounded sands & gravel
 fill material

170B - 9:50 20-28" - dark black

waste material, coarse angular
 gravelly sand, and possible metal
 waste - gray ashy flecks

170C 9:51 32-38" - tan / brown

gravelly clay and sand - no visible
 staining - looks like native material
 - no yellow / green wet mill tailings
 noted in excavation.

TP-171

171A 10:12

- yellow / brown fine gravel, processed
 (crushed) possible mill tailings
 sandy yellow orange Fe-stained

171B 10:14 12-20"

- dark black fine grained metallic
 conc., moist gravelly + sandy

171C 10:17 30-36"

- tan to light brown clayey silty
 homogeneous native fill

TP172 - 20' west of powder magazine

building

- 172A 10:35 18-20"

- composite of native sand & gravel

TP173 - gas line exposed (!)

173A 11:00 0-9"

- dk brown & black w/ blue sherd
 angular to subrounded silica gravel
 - possible asphalt or other hydrocarbon

173B 11:02 10-20"

- black to org / brown FeOx stained stained
 possible metallics

173C 11:04 22-24"

- native clays & sand - silt

4-19-05

TP 174 - At NW corner of Stillman Sunday
building

174A 1136 0-8"

- gray/black angular cobbles & sand, flintish
native sand etc.

174B 1140 14-16"

- light tan to brown well sorted sands and
clays - no staining or dark materials

174C 1143 18-20"

- gray/black to dark black sandy cherted
foundry sand and associated waste

174D 1144 30-32"

- tan to orange/brown fine silted
clays and sand.

SPRING MEADOW LAKE

4/21/05 (Thurs). Left office @ 9am - went
to Old Armory Bldg to pick up the boat ^{1 hour's} from
DEO. Hitch was padlocked - worked w/
Dale Horbort (?) to track down the keys.
Went to Rockland for equipment while
DEO person went to Metcalf Bldg for keys.
Returned & loaded up the boat. Returned
to office for cooler. Got boat in H2O
@ 10:30 AM. Cloudy; no wind;
40°F. Fairbairn + Allmewalt

10:45: Sediment sample retrieved
from SD-201 site (location on map).
Sample is the 1st site on East Arm →
the most southern location on E arm.
Obtained sample w/ Ponar Dredge.
~2 ft of H₂O. Dark black organic silt.

11:02: Sediment sample retrieved
from SD-202 site. N of SD-201
in East Arm. 2 ft of H₂O.
Taken w/ Ponar Dredge. Dark black
~~silt~~ organic silt/clay.

11:15: Sediment sample retrieved
from SD-203 site. N of SD-202 where
E arm opens after a tight narrow.
4 ft of water. Tan/grayish
sandy silt w/ some organic mud.
Ponar dredge.

11:25: Surface water sample
retrieved. SW-201 N of SD-203.
(see map) Filled bottles (2-1 for field
parameters + 1 for dissolved metals)
@ surface. Capped + in cooler. →

14/21/05 cont. SML

11:35: Retrieved Sediment sample SD-204. N of SW-201. Ponardredge. Sandy green + black silt. 3ft water depth.

→ N of SD-205 by footbridge.
11:40: Retrieved SD-205. Ponar. black organic silt. 2ft H₂O

11:45: Retrieved Sediment Sample SD-206. Sandy tan/green w/ black organics. 6ft water depth. NW of SD-205 (around bend).

12:00pm: Surface water sample taken. Filled bottles @ surface (2). SW-202.

12:08: Sediment sample retrieved SD-207.

3ft of water. Ponardredge. Spontion of main lake (N of Stedman bldgs; edge of lake) & black organic sand/silt.

12:12: Sediment sample retrieved SD-208. 2ft of water. Ponardredge. W of SD-207. Black sandy silt.

12:45pm Surface water sample Collected SW-203. S end of E arm (S of SD-201). 2 bottles filled.

1:15 - head back to return boat

2:00 - Return to SML to MW-202 to bail for sampling. Bail H₂O is muddy. Continued development w/ Submersible pump. 29.9 T.D. 25" SW 13.3 SWL

2:10 - 7 gallons purged 9 gallons purged

temp 10.97°C 10.99°C
cond 0.407 mS/cm 0.411 / 0.560 mS/cm
DO 67.9% (7.45 mg/L) 67.0% (7.54 mg/L)
pH 7.46 pH 7.42
ORP 203.6 ORP 203.7
turbidity <100 turbidity

12 gallons purged

temp 10.97°C mS/cm
conduct .561 / .410 → specific
DO 64.4% (7.07 mg/L)
pH 7.45
ORP 201.9

14:20pm
sampled =
clear H₂O
2 bottles

filled (1 for field parameters; 1 for dissolved metals) 14:22

sample

14:20 ending parameters: 10.96°C;
cond. 560 / .410 mS/cm; 62.8% DO (6.89 mg/L)
pH 7.44; ORP 199.8

4/21/05 SHL Cond.

14:35 : drove to oiler MW to sample.

MW-Q1 : used submersible pump ~~at~~
continue dupont B4
sampling

7g purged 14:52

temp 7.03°C specific
cond .557 mS/cm .366 mS/cm
DO 25.9% (2.99 mg/L)
pH 7.76
ORP 55.1

15g purged 15:08

temp 7.3°C
cond .555 .367
DO 22.1% (2.68 mg/L)
pH 7.7
ORP -119.

10g purged 14:58

temp 7.2°C
cond .555 mS/cm .367 mS/cm
DO 22.2% (2.66 mg/L)
pH 7.72
ORP -43.3

T.D. 32.55 23.12 S.D.L.
S.D. 2.1

15:15 - GW sample field parameters
bottle filled

15:17 - GW sample dissolved metal
bottle filled.

RE: Spring Meadow Project File

FIELD NOTES: Sampling June 24, 2005. John Koerth (DEQ) and Don Skaar (FWP Pollution Biologist). Warm sunny day.

Left DEQ LCG building at 12:30 pm with Don Skaar to collect co-located sediment and aquatic insect samples to determine biological uptake of arsenic and other metals from sediment in Spring Meadow Lake State Park. Took TMDL aluminum jon-boat from DEQ to lake for use in sampling effort. Lots of people out swimming and fishing in Spring Meadow Lake, FWP Park Employees on site.

Collected three samples. Bugs collected with net. Sediment with bucket auger. Bucket auger filled and brought to surface. Sediment from top of auger bucket pushed out and collected in sample jar.

1:30 PM SML 301 SD and 301 Bugs. Sample located at point on eastern arm where single narrow waterway separates the southern most portion of the eastern arm from the rest of the eastern arm. 3 feet of water, shade, willows. Dragon Fly nymphs plentiful. Don Skaar took GPS reading of location.

2:30 PM SML 302 SD and 302 Bugs. Sample located at southern most end of eastern arm approximately 30 feet from shore. Don Skaar took GPS reading for location. 2 feet of water, limited shade. Sedges. Dragon Fly nymphs less plentiful. Damsel Fly more common.

3:30 PM SML 303 SD and 303 Bugs. Sample location between first two locations at narrow channel with shade and brush. 3 feet of water, shade, willows. Don Skaar took GPS reading of location. Dragon Fly nymphs plentiful. Other aquatic insects less common.

Left site at 4:10. Returned to DEQ. Don Skaar to submit samples to the State Laboratory for analysis. DEQ to pay invoice.

Bugs and sediment to be sampled for: Sb, As, Ba, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Ni, Ag, Zn. (existing sediment data for these elements).

APPENDIX 5-B
RECLAMATION INVESTIGATION ANALYTICAL DATA

REPORT TO: ATTN: JOHN KOERTH
MONTANA DEPT. OF ENVIRONMENTAL QUALITY
P.O. BOX 200901
HELENA, MT 59620-0901

DATE: May 12, 2005
JOB NUMBER: 90-933-14
PAGE: 1 of 70
INVOICE NO.: 5040193

REPORT OF: Soil Analysis – Spring Meadow Lake (SML) – S1129-30SMLSRI

CASE NARRATIVE:

On April 22, 2005 these soil samples (laboratory numbers 2005040193-1 through -54) were received in our laboratory for analysis. Tests were conducted in accordance with SW-846 "Test Methods for Evaluating Solid Waste", 3rd Edition, updates I, II, IIA, IIB, III; American Society of Agronomy "Methods of Soil Analysis"; USDA Handbook No. 60, "Diagnosis and Improvement of Saline and Alkali Solids"; Western States Laboratory Proficiency Testing Program, "Soil & Plant Analytical Methods"; and "Standard Methods for the Examination of Water and Wastewater", 18th Edition.

The results of the analysis are shown on the following pages. A < sign indicates the value reported was the practical quantitation limit for this sample using the method described. Concentrations of analyte, if present, below this were not quantifiable. Sample results are not corrected for analyte blank concentrations. Values in brackets are the quality control limits for the associated quality control test. RPD is the abbreviation for relative percent difference.

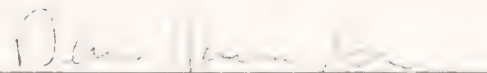
The condition of the samples upon receipt at the laboratory is noted on the attached sample receipt checklist. Chain of custody documentation is enclosed.

Footnotes used in this report include the following:

J – The associated value is an estimated quantity.

- (2) The recovery of the matrix spike is outside the stated quality control limit. However, the sample result was greater than four times the spike added; therefore no corrective action was required.
- (4) The recovery of this analyte in the matrix spike and/or its spike duplicate did not meet the quality control limits. The recovery of the analyte in the laboratory control sample met the control limits. This indicates the presence of a matrix interference in the sample. The associated sample results have been footnoted with a data qualifier.
- (6) The recovery or replication is outside the stated control limit. The associated sample results have been footnoted with a data qualifier.

Reviewed by


Kathleen A. Smit - Laboratory Manager

Cc: Attn: Ed Surbrugg
Tetra Tech EMI
7 West 6th Ave.; Suite 612
Helena, MT 59601

Attachments: Chain of Custody (5)
Sample Receipt Checklist

nct

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-1

Description: TP-151

Matrix: SOIL

Date Received: 04/22/2005

Date Collected: 04/18/2005

Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<5	mg/kg	6020	05/03/2005
Arsenic Dry Basis	219	mg/kg	6010B	04/28/2005
Barium Dry Basis	112	mg/kg	6010B	04/28/2005
Cadmium Dry Basis	2	mg/kg	6010B	04/28/2005
Chromium Dry Basis	12	mg/kg	6010B	04/28/2005
Copper Dry Basis	29	mg/kg	6010B	04/28/2005
Cobalt Dry Basis	18,300	mg/kg	6010B	05/02/2005
Lead Dry Basis	154	mg/kg	6010B	04/28/2005
Manganese Dry Basis	3750	mg/kg	6010B	05/02/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	6	mg/kg	6010B	04/28/2005
Silver Dry Basis	<5	mg/kg	6010B	04/28/2005
Zinc Dry Basis	356	mg/kg	6010B	04/28/2005
CP/AA Batch#/Digest Date	1262	-----	3050B-M	04/26/2005
CPMS Batch#/Digest Date	1265	-----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1265	-----	3050B-HG	04/28/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-2	Description: TP-152	Matrix: SOIL
Date Received: 04/22/2005		
Date Collected: 04/18/2005	Collected by: JOE FAUBION	

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<5	mg/kg	6020	05/03/2005
Arsenic Dry Basis	54	mg/kg	6010B	05/02/2005
Barium Dry Basis	56	mg/kg	6010B	04/28/2005
Cadmium Dry Basis	<10	mg/kg	6010B	05/02/2005
Chromium Dry Basis	74	mg/kg	6010B	04/28/2005
Copper Dry Basis	17	mg/kg	6010B	04/28/2005
Iron Dry Basis	94,400	mg/kg	6010B	05/02/2005
Lead Dry Basis	140	mg/kg	6010B	04/28/2005
Manganese Dry Basis	2240	mg/kg	6010B	05/02/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	9	mg/kg	6010B	04/28/2005
Silver Dry Basis	<25	mg/kg	6010B	05/02/2005
Zinc Dry Basis	81	mg/kg	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1262	-----	3050B-M	04/26/2005
ICPMS Batch#/Digest Date	1265	-----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1265	-----	3050B-HG	04/28/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-3	Description: TP-153A	Matrix: SOIL
Date Received: 04/22/2005		
Date Collected: 04/18/2005	Collected by: JOE FAUBION	

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<5	mg/kg	6020	05/03/2005
Arsenic Dry Basis	329	mg/kg	6010B	04/28/2005
Barium Dry Basis	102	mg/kg	6010B	04/28/2005
Cadmium Dry Basis	3	mg/kg	6010B	04/28/2005
Chromium Dry Basis	26	mg/kg	6010B	04/28/2005
Copper Dry Basis	45	mg/kg	6010B	04/28/2005
Iron Dry Basis	33,200	mg/kg	6010B	05/02/2005
Lead Dry Basis	247	mg/kg	6010B	04/28/2005
Manganese Dry Basis	4620	mg/kg	6010B	05/02/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	8	mg/kg	6010B	04/28/2005
Silver Dry Basis	<5	mg/kg	6010B	04/28/2005
Zinc Dry Basis	345	mg/kg	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1262	-----	3050B-M	04/26/2005
ICPMS Batch#/Digest Date	1265	-----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1265	-----	3050B-HG	04/28/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-4

Description: TP-153B

Matrix: SOIL

Date Received: 04/22/2005

Date Collected: 04/18/2005

Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<5	mg/kg	6020	05/03/2005
Arsenic Dry Basis	<50	mg/kg	6010B	05/02/2005
Barium Dry Basis	71	mg/kg	6010B	04/28/2005
Cadmium Dry Basis	<10	mg/kg	6010B	05/02/2005
Chromium Dry Basis	52	mg/kg	6010B	04/28/2005
Copper Dry Basis	18	mg/kg	6010B	04/28/2005
Iron Dry Basis	62,500	mg/kg	6010B	05/02/2005
Lead Dry Basis	89	mg/kg	6010B	04/28/2005
Manganese Dry Basis	1490	mg/kg	6010B	05/02/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	7	mg/kg	6010B	04/28/2005
Silver Dry Basis	<25	mg/kg	6010B	05/02/2005
Zinc Dry Basis	106	mg/kg	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1262	----	3050B-M	04/26/2005
ICPMS Batch#/Digest Date	1265	----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1265	----	3050B-HG	04/28/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-5	Description: TP-154A	Matrix: SOIL
Date Received: 04/22/2005		
Date Collected: 04/18/2005	Collected by: JOE FAUBION	

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	22	mg/kg	6020	05/03/2005
Arsenic Dry Basis	879	mg/kg	6010B	04/28/2005
Barium Dry Basis	264	mg/kg	6010B	04/28/2005
Cadmium Dry Basis	8	mg/kg	6010B	04/28/2005
Chromium Dry Basis	31	mg/kg	6010B	04/28/2005
Copper Dry Basis	144	mg/kg	6010B	04/28/2005
Iron Dry Basis	25,000	mg/kg	6010B	05/02/2005
Lead Dry Basis	998	mg/kg	6010B	04/28/2005
Manganese Dry Basis	41,400	mg/kg	6010B	05/02/2005
Mercury Dry Basis	0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	8	mg/kg	6010B	04/28/2005
Silver Dry Basis	14	mg/kg	6010B	04/28/2005
Zinc Dry Basis	1460	mg/kg	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1262	-----	3050B-M	04/26/2005
ICPMS Batch#/Digest Date	1265	-----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1265	-----	3050B-HG	04/28/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-6	Description: TP-154B	Matrix: SOIL
Date Received: 04/22/2005		
Date Collected: 04/18/2005	Collected by: JOE FAUBION	

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<5	mg/kg	6020	05/03/2005
Arsenic Dry Basis	44	mg/kg	6010B	04/28/2005
Barium Dry Basis	31	mg/kg	6010B	04/28/2005
Cadmium Dry Basis	<2	mg/kg	6010B	04/28/2005
Chromium Dry Basis	10	mg/kg	6010B	04/28/2005
Copper Dry Basis	15	mg/kg	6010B	04/28/2005
Iron Dry Basis	14,200	mg/kg	6010B	05/02/2005
Lead Dry Basis	72	mg/kg	6010B	04/28/2005
Manganese Dry Basis	446	mg/kg	6010B	04/28/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	<5	mg/kg	6010B	04/28/2005
Silver Dry Basis	<5	mg/kg	6010B	04/28/2005
Zinc Dry Basis	77	mg/kg	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1262	-----	3050B-M	04/26/2005
ICPMS Batch#/Digest Date	1265	-----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1265	-----	3050B-HG	04/28/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-7	Description: TP-155A	Matrix: SOIL
Date Received: 04/22/2005		
Date Collected: 04/18/2005	Collected by: JOE FAUBION	

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	17	mg/kg	6020	05/03/2005
Arsenic Dry Basis	434	mg/kg	6010B	04/28/2005
Barium Dry Basis	289	mg/kg	6010B	04/28/2005
Cadmium Dry Basis	5	mg/kg	6010B	04/28/2005
Chromium Dry Basis	33	mg/kg	6010B	04/28/2005
Copper Dry Basis	126	mg/kg	6010B	04/28/2005
Iron Dry Basis	20,000	mg/kg	6010B	05/02/2005
Lead Dry Basis	677	mg/kg	6010B	04/28/2005
Manganese Dry Basis	41,700	mg/kg	6010B	05/02/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	6	mg/kg	6010B	04/28/2005
Silver Dry Basis	12	mg/kg	6010B	04/28/2005
Zinc Dry Basis	1260	mg/kg	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1262	-----	3050B-M	04/26/2005
CPMS Batch#/Digest Date	1265	-----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1265	-----	3050B-HG	04/28/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-8	Description: TP-155B	Matrix: SOIL
Date Received: 04/22/2005		
Date Collected: 04/18/2005	Collected by: JOE FAUBION	

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<5	mg/kg	6020	05/03/2005
Arsenic Dry Basis	37	mg/kg	6010B	04/28/2005
Barium Dry Basis	80	mg/kg	6010B	04/28/2005
Cadmium Dry Basis	<2	mg/kg	6010B	04/28/2005
Chromium Dry Basis	16	mg/kg	6010B	04/28/2005
Copper Dry Basis	24	mg/kg	6010B	04/28/2005
Iron Dry Basis	21,100	mg/kg	6010B	05/02/2005
Lead Dry Basis	75	mg/kg	6010B	04/28/2005
Manganese Dry Basis	425	mg/kg	6010B	04/28/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	10	mg/kg	6010B	04/28/2005
Silver Dry Basis	<5	mg/kg	6010B	04/28/2005
Zinc Dry Basis	87	mg/kg	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1262	-----	3050B-M	04/26/2005
ICPMS Batch#/Digest Date	1265	-----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1265	-----	3050B-HG	04/28/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-10	Description: TP-156B	Matrix: SOIL
Date Received: 04/22/2005		
Date Collected: 04/18/2005	Collected by: JOE FAUBION	

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
INORGANICS				
Chloride (Water Soluble)	114	mg/kg	3c MOD	04/29/2005
Hardness as CaCO3	2600	mg/l	2340B	05/13/2005
Cation Exchange Capacity	16.4	meq/100g	19 ASA	05/12/2005
Electrical Conductivity Saturated Paste	4.22	mmhos/cm	3a	04/29/2005
pH Saturated Paste	7.5	S.U.	21(a) ASA	04/29/2005
Calcium saturated paste	21.9	meq/l	6010B	05/13/2005
Magnesium saturated paste	30.1	meq/l	6010B	05/13/2005
Sulfate Water Soluble Dry Basis	0.26	%	10-3.7MOD	04/29/2005
PARTICLE SIZE ANALYSIS				
Sand	51.3	%	42b mod.	05/03/2005
Silt	31.2	%	42b mod.	05/03/2005
Clay	17.5	%	42b mod.	05/03/2005
Texture	Loam		42b mod.	05/03/2005
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	9	mg/kg	6020	05/03/2005
Arsenic Dry Basis	624	mg/kg	6010B	04/28/2005
Barium Dry Basis	224	mg/kg	6010B	04/28/2005
Cadmium Dry Basis	6	mg/kg	6010B	04/28/2005
Chromium Dry Basis	12	mg/kg	6010B	04/28/2005
Copper Dry Basis	77	mg/kg	6010B	04/28/2005
Iron Dry Basis	18,000	mg/kg	6010B	05/02/2005
Lead Dry Basis	572	mg/kg	6010B	04/28/2005
Manganese Dry Basis	5340	mg/kg	6010B	05/02/2005
Mercury Dry Basis	0.6	mg/kg	6020A	05/02/2005
Nickel Dry Basis	8	mg/kg	6010B	04/28/2005
Silver Dry Basis	<5	mg/kg	6010B	04/28/2005
Zinc Dry Basis	608	mg/kg	6010B	04/28/2005
CP/AA Batch#/Digest Date	1262	----	3050B-M	04/26/2005
CPMS Batch#/Digest Date	1265	----	3050B-SB	04/26/2005
Mercury Batch #/Digest Date	1265	----	3050B-HG	04/28/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-9

Description: TP-156A

Matrix: SOIL

Date Received: 04/22/2005

Date Collected: 04/18/2005

Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<5	mg/kg	6020	05/03/2005
Arsenic Dry Basis	101	mg/kg	6010B	04/28/2005
Barium Dry Basis	85	mg/kg	6010B	04/28/2005
Cadmium Dry Basis	<2	mg/kg	6010B	04/28/2005
Chromium Dry Basis	11	mg/kg	6010B	04/28/2005
Copper Dry Basis	35	mg/kg	6010B	04/28/2005
Iron Dry Basis	17,000	mg/kg	6010B	05/02/2005
Lead Dry Basis	83	mg/kg	6010B	04/28/2005
Manganese Dry Basis	1070	mg/kg	6010B	04/28/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	8	mg/kg	6010B	04/28/2005
Silver Dry Basis	<5	mg/kg	6010B	04/28/2005
Zinc Dry Basis	116	mg/kg	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1262	-----	3050B-M	04/26/2005
ICPMS Batch#/Digest Date	1265	-----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1265	-----	3050B-HG	04/28/2005

Northern Analytical Laboratories, Inc.

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Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-11

Description: TP-157A

Matrix: SOIL

Date Received: 04/22/2005

Date Collected: 04/18/2005

Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
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TARGET ANALYTE LIST (SOIL)

Antimony Dry Basis	<5	mg/kg	6020	05/03/2005
Arsenic Dry Basis	180	mg/kg	6010B	04/28/2005
Barium Dry Basis	149	mg/kg	6010B	04/28/2005
Cadmium Dry Basis	3	mg/kg	6010B	04/28/2005
Chromium Dry Basis	11	mg/kg	6010B	04/28/2005
Copper Dry Basis	37	mg/kg	6010B	04/28/2005
Iron Dry Basis	16,600	mg/kg	6010B	05/02/2005
Lead Dry Basis	146	mg/kg	6010B	04/28/2005
Manganese Dry Basis	3030	mg/kg	6010B	05/02/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	10	mg/kg	6010B	04/28/2005
Silver Dry Basis	<5	mg/kg	6010B	04/28/2005
Zinc Dry Basis	530	mg/kg	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1262	-----	3050B-M	04/26/2005
CPMS Batch#/Digest Date	1265	-----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1265	-----	3050B-HG	04/28/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSR1

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-12 Description: TP-157B Matrix: SOIL
 Date Received: 04/22/2005
 Date Collected: 04/18/2005 Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
INORGANICS				
Chloride (Water Soluble)	<20	mg/kg	3c MOD	04/29/2005
Hardness as CaCO3	217	mg/l	2340B	05/13/2005
Cation Exchange Capacity	11.9	meq/100g	19 ASA	05/12/2005
Electrical Conductivity Saturated Paste	0.34	mmhos/cm	3a	04/29/2005
pH Saturated Paste	7.8	S.U.	21(a) ASA	04/29/2005
Calcium saturated paste	3.34	meq/l	6010B	05/13/2005
Magnesium saturated paste	0.99	meq/l	6010B	05/13/2005
Sulfate Water Soluble Dry Basis	<0.01	%	10-3.7MOD	04/29/2005
PARTICLE SIZE ANALYSIS				
Sand	43.8	%	42b mod.	05/03/2005
Silt	36.2	%	42b mod.	05/03/2005
Clay	20.0	%	42b mod.	05/03/2005
Texture	Loam		42b mod.	05/03/2005
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<5	mg/kg	6020	05/03/2005
Arsenic Dry Basis	45	mg/kg	6010B	04/28/2005
Barium Dry Basis	133	mg/kg	6010B	04/28/2005
Cadmium Dry Basis	<2	mg/kg	6010B	04/28/2005
Chromium Dry Basis	13	mg/kg	6010B	04/28/2005
Copper Dry Basis	20	mg/kg	6010B	04/28/2005
Iron Dry Basis	17,700	mg/kg	6010B	05/02/2005
Lead Dry Basis	37	mg/kg	6010B	04/28/2005
Manganese Dry Basis	292	mg/kg	6010B	04/28/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	9	mg/kg	6010B	04/28/2005
Silver Dry Basis	<5	mg/kg	6010B	04/28/2005
Zinc Dry Basis	62	mg/kg	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1262	----	3050B-M	04/26/2005
ICPMS Batch#/Digest Date	1265	----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1265	----	3050B-HG	04/28/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-13	Description: TP-158A	Matrix: SOIL
Date Received: 04/22/2005		
Date Collected: 04/18/2005	Collected by: JOE FAUBION	

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	22	mg/kg	6020	05/03/2005
Arsenic Dry Basis	1460	mg/kg	6010B	04/28/2005
Barium Dry Basis	422	mg/kg	6010B	04/28/2005
Cadmium Dry Basis	17	mg/kg	6010B	04/28/2005
Chromium Dry Basis	35	mg/kg	6010B	04/28/2005
Copper Dry Basis	218	mg/kg	6010B	04/28/2005
Iron Dry Basis	15,600	mg/kg	6010B	05/02/2005
Lead Dry Basis	1310	mg/kg	6010B	04/28/2005
Manganese Dry Basis	111,000	mg/kg	6010B	05/02/2005
Mercury Dry Basis	0.6	mg/kg	6020A	05/02/2005
Nickel Dry Basis	<5	mg/kg	6010B	04/28/2005
Silver Dry Basis	27	mg/kg	6010B	04/28/2005
Zinc Dry Basis	3380	mg/kg	6010B	05/02/2005
ICP/AA Batch#/Digest Date	1262	-----	3050B-M	04/26/2005
ICPMS Batch#/Digest Date	1265	-----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1265	-----	3050B-HG	04/28/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-14 Description: TP-158B Matrix: SOIL
 Date Received: 04/22/2005
 Date Collected: 04/18/2005 Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
INORGANICS				
Chloride (Water Soluble)	24	mg/kg	3c MOD	04/29/2005
Hardness as CaCO ₃	203J	mg/l	2340B	05/06/2005
Cation Exchange Capacity	5.6	meq/100g	19 ASA	05/12/2005
Electrical Conductivity Saturated Paste	0.46	mmhos/cm	3a	04/29/2005
pH Saturated Paste	7.8	S.U.	21(a) ASA	04/29/2005
Calcium saturated paste	2.99J	meq/l	6010B	05/06/2005
Magnesium saturated paste	1.07J	meq/l	6010B	05/06/2005
Sulfate Water Soluble Dry Basis	<0.01	%	10-3.7MOD	04/29/2005
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<5	mg/kg	6020	05/03/2005
Arsenic Dry Basis	62	mg/kg	6010B	04/28/2005
Barium Dry Basis	75	mg/kg	6010B	04/28/2005
Cadmium Dry Basis	<2	mg/kg	6010B	04/28/2005
Chromium Dry Basis	14	mg/kg	6010B	04/28/2005
Copper Dry Basis	24	mg/kg	6010B	04/28/2005
Iron Dry Basis	17,600	mg/kg	6010B	05/02/2005
Lead Dry Basis	76	mg/kg	6010B	04/28/2005
Manganese Dry Basis	1420	mg/kg	6010B	04/28/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	7	mg/kg	6010B	04/28/2005
Silver Dry Basis	<5	mg/kg	6010B	04/28/2005
Zinc Dry Basis	109	mg/kg	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1262	-----	3050B-M	04/26/2005
ICPMS Batch#/Digest Date	1265	-----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1265	-----	3050B-HG	04/28/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-15 Description: TP-159A Matrix: SOIL

Date Received: 04/22/2005

Date Collected: 04/18/2005 Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	15	mg/kg	6020	05/03/2005
Arsenic Dry Basis	1290	mg/kg	6010B	04/28/2005
Barium Dry Basis	232	mg/kg	6010B	04/28/2005
Cadmium Dry Basis	17	mg/kg	6010B	04/28/2005
Chromium Dry Basis	16	mg/kg	6010B	04/28/2005
Copper Dry Basis	123	mg/kg	6010B	04/28/2005
Iron Dry Basis	18.000	mg/kg	6010B	05/02/2005
Lead Dry Basis	926	mg/kg	6010B	04/28/2005
Manganese Dry Basis	29,100	mg/kg	6010B	04/28/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	6	mg/kg	6010B	04/28/2005
Silver Dry Basis	13	mg/kg	6010B	04/28/2005
Zinc Dry Basis	2260	mg/kg	6010B	05/02/2005
ICP/AA Batch#/Digest Date	1262	----	3050B-M	04/26/2005
ICPMS Batch#/Digest Date	1265	----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1265	----	3050B-HG	04/28/2005

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Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-16 Description: TP-160A Matrix: SOIL

Date Received: 04/22/2005

Date Collected: 04/18/2005 Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	61	mg/kg	6020	05/03/2005
Arsenic Dry Basis	5400	mg/kg	6010B	05/02/2005
Barium Dry Basis	465	mg/kg	6010B	04/28/2005
Cadmium Dry Basis	41	mg/kg	6010B	04/28/2005
Chromium Dry Basis	28	mg/kg	6010B	04/28/2005
Copper Dry Basis	377	mg/kg	6010B	04/28/2005
Iron Dry Basis	24,000	mg/kg	6010B	05/02/2005
Lead Dry Basis	3330	mg/kg	6010B	04/28/2005
Manganese Dry Basis	85,500	mg/kg	6010B	04/28/2005
Mercury Dry Basis	0.9	mg/kg	6020A	05/02/2005
Nickel Dry Basis	<5	mg/kg	6010B	04/28/2005
Silver Dry Basis	50	mg/kg	6010B	04/28/2005
Zinc Dry Basis	5730	mg/kg	6010B	05/02/2005
ICP/AA Batch#/Digest Date	1262	----	3050B-M	04/26/2005
ICPMS Batch#/Digest Date	1265	----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1265	----	3050B-HG	04/28/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-17

Description: TP-161A

Matrix: SOIL

Date Received: 04/22/2005

Date Collected: 04/18/2005

Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	13	mg/kg	6020	05/03/2005
Arsenic Dry Basis	804	mg/kg	6010B	04/28/2005
Barium Dry Basis	106	mg/kg	6010B	04/28/2005
Cadmium Dry Basis	8	mg/kg	6010B	04/28/2005
Chromium Dry Basis	14	mg/kg	6010B	04/28/2005
Copper Dry Basis	74	mg/kg	6010B	04/28/2005
Iron Dry Basis	17,400	mg/kg	6010B	05/02/2005
Lead Dry Basis	614	mg/kg	6010B	04/28/2005
Manganese Dry Basis	12,100	mg/kg	6010B	04/28/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	<5	mg/kg	6010B	04/28/2005
Silver Dry Basis	6	mg/kg	6010B	04/28/2005
Zinc Dry Basis	841	mg/kg	6010B	04/28/2005
ICP/AA Batch# Digest Date	1262	----	3050B-M	04/26/2005
CPMS Batch#/Digest Date	1265	----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1265	----	3050B-HG	04/28/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-18 Description: TP-162A Matrix: SOIL
 Date Received: 04/22/2005
 Date Collected: 04/18/2005 Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	7	mg/kg	6020	05/03/2005
Arsenic Dry Basis	126	mg/kg	6010B	04/28/2005
Barium Dry Basis	150	mg/kg	6010B	04/28/2005
Cadmium Dry Basis	2	mg/kg	6010B	04/28/2005
Chromium Dry Basis	16	mg/kg	6010B	04/28/2005
Copper Dry Basis	61	mg/kg	6010B	04/28/2005
Iron Dry Basis	18,600	mg/kg	6010B	05/02/2005
Lead Dry Basis	269	mg/kg	6010B	04/28/2005
Manganese Dry Basis	15,000	mg/kg	6010B	04/28/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	<5	mg/kg	6010B	04/28/2005
Silver Dry Basis	<5	mg/kg	6010B	04/28/2005
Zinc Dry Basis	603	mg/kg	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1262	----	3050B-M	04/26/2005
ICPMS Batch#/Digest Date	1265	----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1265	----	3050B-HG	04/28/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-19 Description: TP-162B Matrix: SOIL
 Date Received: 04/22/2005
 Date Collected: 04/18/2005 Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
INORGANICS				
Chloride (Water Soluble)	24	mg/kg	3c MOD	04/29/2005
Hardness as CaCO3	255	mg/l	2340B	05/13/2005
Cation Exchange Capacity	21.5	meq/100g	19 ASA	05/12/2005
Electrical Conductivity Saturated Paste	0.77	mmhos/cm	3a	04/29/2005
pH Saturated Paste	7.9	S.U.	21(a) ASA	04/29/2005
Calcium saturated paste	3.29	meq/l	6010B	05/13/2005
Magnesium saturated paste	1.81	meq/l	6010B	05/13/2005
Sulfate Water Soluble Dry Basis	<0.01	%	10-3.7MOD	04/29/2005
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<5	mg/kg	6020	05/03/2005
Arsenic Dry Basis	100	mg/kg	6010B	04/28/2005
Barium Dry Basis	161	mg/kg	6010B	04/28/2005
Cadmium Dry Basis	<2	mg/kg	6010B	04/28/2005
Chromium Dry Basis	19	mg/kg	6010B	04/28/2005
Copper Dry Basis	73	mg/kg	6010B	04/28/2005
Iron Dry Basis	24,500	mg/kg	6010B	05/02/2005
Lead Dry Basis	115	mg/kg	6010B	04/28/2005
Manganese Dry Basis	1730	mg/kg	6010B	04/28/2005
Mercury Dry Basis	0.6	mg/kg	6020A	05/02/2005
Nickel Dry Basis	15	mg/kg	6010B	04/28/2005
Silver Dry Basis	<5	mg/kg	6010B	04/28/2005
Zinc Dry Basis	187	mg/kg	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1262	----	3050B-M	04/26/2005
ICPMS Batch#/Digest Date	1265	----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1265	----	3050B-HG	04/28/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-20 Description: TP-163A Matrix: SOIL
 Date Received: 04/22/2005
 Date Collected: 04/18/2005 Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<5	mg/kg	6020	05/03/2005
Arsenic Dry Basis	172	mg/kg	6010B	04/28/2005
Barium Dry Basis	155	mg/kg	6010B	04/28/2005
Cadmium Dry Basis	<2	mg/kg	6010B	04/28/2005
Chromium Dry Basis	11	mg/kg	6010B	04/28/2005
Copper Dry Basis	113	mg/kg	6010B	04/28/2005
Iron Dry Basis	19,400	mg/kg	6010B	05/02/2005
Lead Dry Basis	189	mg/kg	6010B	04/28/2005
Manganese Dry Basis	5220	mg/kg	6010B	04/28/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	10	mg/kg	6010B	04/28/2005
Silver Dry Basis	<5	mg/kg	6010B	04/28/2005
Zinc Dry Basis	274	mg/kg	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1262	-----	3050B-M	04/26/2005
ICPMS Batch#/Digest Date	1265	-----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1265	-----	3050B-HG	04/29/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-21

Description: TP-164A

Matrix: SOIL

Date Received: 04/22/2005

Date Collected: 04/18/2005

Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	23	mg/kg	6020	05/03/2005
Arsenic Dry Basis	754	mg/kg	6010B	04/28/2005
Barium Dry Basis	539	mg/kg	6010B	04/28/2005
Cadmium Dry Basis	12	mg/kg	6010B	04/28/2005
Chromium Dry Basis	40	mg/kg	6010B	04/28/2005
Copper Dry Basis	241	mg/kg	6010B	04/28/2005
Iron Dry Basis	15,200	mg/kg	6010B	05/02/2005
Lead Dry Basis	1220	mg/kg	6010B	04/28/2005
Manganese Dry Basis	122,000	mg/kg	6010B	05/09/2005
Mercury Dry Basis	0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	<5	mg/kg	6010B	04/28/2005
Silver Dry Basis	30	mg/kg	6010B	04/28/2005
Zinc Dry Basis	2680	mg/kg	6010B	05/02/2005
ICP/AA Batch#/Digest Date	1263	---	3050B-M	04/26/2005
ICPMS Batch#/Digest Date	1267	---	3050B-SB	04/29/2005
Mercury Batch #/Digest Date	1267	---	3050B-HG	04/29/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-22 Description: TP-164B Matrix: SOIL
 Date Received: 04/22/2005
 Date Collected: 04/18/2005 Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
INORGANICS				
Chloride (Water Soluble)	48	mg/kg	3c MOD	04/29/2005
Hardness as CaCO ₃	2000	mg/l	2340B	05/13/2005
Cation Exchange Capacity	18.3	meq/100g	19 ASA	05/12/2005
Electrical Conductivity Saturated Paste	2.62	mmhos/cm	3a	04/29/2005
pH Saturated Paste	7.6	S.U.	21(a) ASA	04/29/2005
Calcium saturated paste	24.8	meq/l	6010B	05/13/2005
Magnesium saturated paste	15.2	meq/l	6010B	05/13/2005
Sulfate Water Soluble Dry Basis	0.17	%	10-3.7MOD	04/29/2005
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	6	mg/kg	6020	05/03/2005
Arsenic Dry Basis	461	mg/kg	6010B	04/28/2005
Barium Dry Basis	196	mg/kg	6010B	04/28/2005
Cadmium Dry Basis	8	mg/kg	6010B	04/28/2005
Chromium Dry Basis	17	mg/kg	6010B	04/28/2005
Copper Dry Basis	104	mg/kg	6010B	04/28/2005
Iron Dry Basis	29,700	mg/kg	6010B	05/02/2005
Lead Dry Basis	373	mg/kg	6010B	04/28/2005
Manganese Dry Basis	4230	mg/kg	6010B	04/28/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	12	mg/kg	6010B	04/28/2005
Silver Dry Basis	<5	mg/kg	6010B	04/28/2005
Zinc Dry Basis	1260	mg/kg	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1263	----	3050B-M	04/26/2005
ICPMS Batch#/Digest Date	1267	----	3050B-SB	04/29/2005
Mercury Batch #/Digest Date	1267	----	3050B-HG	04/29/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-23 Description: TP-165A Matrix: SOIL
Date Received: 04/22/2005
Date Collected: 04/18/2005 Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	6	mg/kg	6020	05/03/2005
Arsenic Dry Basis	502	mg/kg	6010B	04/28/2005
Barium Dry Basis	136	mg/kg	6010E	04/28/2005
Cadmium Dry Basis	4	mg/kg	6010B	04/28/2005
Chromium Dry Basis	18	mg/kg	6010B	04/28/2005
Copper Dry Basis	66	mg/kg	6010B	04/28/2005
Iron Dry Basis	22,900	mg/kg	6010B	05/02/2005
Lead Dry Basis	389	mg/kg	6010B	04/28/2005
Manganese Dry Basis	12,200	mg/kg	6010B	04/28/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	6	mg/kg	6010B	04/28/2005
Silver Dry Basis	<5	mg/kg	6010B	04/28/2005
Zinc Dry Basis	566	mg/kg	6010E	04/28/2005
ICP/AA Batch#/Digest Date	1263	----	3050B-M	04/26/2005
CPMS Batch#/Digest Date	1267	----	3050B-SB	04/29/2005
Mercury Batch #/Digest Date	1267	----	3050B-HG	04/29/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-24 Description: TP-166A Matrix: SOIL

Date Received: 04/22/2005

Date Collected: 04/18/2005 Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	12	mg/kg	6020	05/03/2005
Arsenic Dry Basis	570	mg/kg	6010B	04/28/2005
Barium Dry Basis	194	mg/kg	6010B	04/28/2005
Cadmium Dry Basis	5	mg/kg	6010B	04/28/2005
Chromium Dry Basis	14	mg/kg	6010B	04/28/2005
Copper Dry Basis	102	mg/kg	6010B	04/28/2005
Iron Dry Basis	15,800	mg/kg	6010B	05/02/2005
Lead Dry Basis	537	mg/kg	6010B	04/28/2005
Manganese Dry Basis	27,900	mg/kg	6010B	04/28/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	<5	mg/kg	6010B	04/28/2005
Silver Dry Basis	8	mg/kg	6010B	04/28/2005
Zinc Dry Basis	1130	mg/kg	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1263	----	3050B-M	04/26/2005
ICPMS Batch#/Digest Date	1267	----	3050B-SB	04/29/2005
Mercury Batch #/Digest Date	1267	----	3050B-HG	04/29/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-25 Description: TP-166B Matrix: SOIL
Date Received: 04/22/2005
Date Collected: 04/18/2005 Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<5	mg/kg	6020	05/03/2005
Arsenic Dry Basis	26	mg/kg	6010B	04/28/2005
Barium Dry Basis	44	mg/kg	6010B	04/28/2005
Cadmium Dry Basis	<2	mg/kg	6010B	04/28/2005
Chromium Dry Basis	5	mg/kg	6010B	04/28/2005
Copper Dry Basis	<10	mg/kg	6010B	04/28/2005
Iron Dry Basis	7840	mg/kg	6010B	04/28/2005
Lead Dry Basis	20	mg/kg	6010B	04/28/2005
Manganese Dry Basis	347	mg/kg	6010B	04/28/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	<5	mg/kg	6010B	04/28/2005
Silver Dry Basis	<5	mg/kg	6010B	04/28/2005
Zinc Dry Basis	36	mg/kg	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1263	-----	3050B-M	04/26/2005
CPMS Batch#/Digest Date	1267	-----	3050B-SB	04/29/2005
Mercury Batch #/Digest Date	1267	-----	3050B-HG	04/29/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-26 Description: TP-167A Matrix: SOIL

Date Received: 04/22/2005

Date Collected: 04/18/2005 Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	93	mg/kg	6020	05/03/2005
Arsenic Dry Basis	10.400	mg/kg	6010B	05/02/2005
Barium Dry Basis	494	mg/kg	6010B	04/28/2005
Cadmium Dry Basis	13	mg/kg	6010B	04/28/2005
Chromium Dry Basis	18	mg/kg	6010B	04/28/2005
Copper Dry Basis	265	mg/kg	6010B	04/28/2005
Iron Dry Basis	22,400	mg/kg	6010B	05/02/2005
Lead Dry Basis	6180	mg/kg	6010B	05/02/2005
Manganese Dry Basis	53,200	mg/kg	6010B	04/28/2005
Mercury Dry Basis	0.6	mg/kg	6020A	05/02/2005
Nickel Dry Basis	<5	mg/kg	6010B	04/28/2005
Silver Dry Basis	54	mg/kg	6010B	04/28/2005
Zinc Dry Basis	2490	mg/kg	6010B	05/02/2005
ICP/AA Batch#/Digest Date	1263	----	3050B-M	04/26/2005
ICPMS Batch#/Digest Date	1267	----	3050B-SB	04/29/2005
Mercury Batch #/Digest Date	1267	----	3050B-HG	04/29/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-27 Description: TP-167B

Matrix: SOIL

Date Received: 04/22/2005

Date Collected: 04/18/2005 Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
INORGANICS				
Chloride (Water Soluble)	<20	mg/kg	3c MOD	04/29/2005
Hardness as CaCO ₃	135	mg/l	2340B	05/13/2005
Cation Exchange Capacity	5.0	meq/100g	19 ASA	05/12/2005
Electrical Conductivity Saturated Paste	0.31	mmhos/cm	3a	04/29/2005
pH Saturated Paste	8.1	S.U.	21(a) ASA	04/29/2005
Calcium saturated paste	2.05	meq/l	6010B	05/13/2005
Magnesium saturated paste	0.66	meq/l	6010B	05/13/2005
Sulfate Water Soluble Dry Basis	<0.01	%	10-3.7MOD	04/29/2005
PARTICLE SIZE ANALYSIS				
Sand	88.8	%	42b mod.	05/03/2005
Silt	8.7	%	42b mod.	05/03/2005
Clay	2.5	%	42b mod.	05/03/2005
Texture	Sand		42b mod.	05/03/2005
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<5	mg/kg	6020	05/03/2005
Arsenic Dry Basis	101	mg/kg	6010B	04/28/2005
Barium Dry Basis	57	mg/kg	6010B	04/28/2005
Cadmium Dry Basis	<2	mg/kg	6010B	04/28/2005
Chromium Dry Basis	12	mg/kg	6010B	04/28/2005
Copper Dry Basis	25	mg/kg	6010B	04/28/2005
Cobalt Dry Basis	15,600	mg/kg	6010B	05/02/2005
Lead Dry Basis	82	mg/kg	6010B	04/28/2005
Manganese Dry Basis	1210	mg/kg	6010B	04/28/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	<5	mg/kg	6010B	04/28/2005
Silver Dry Basis	<5	mg/kg	6010B	04/28/2005
Zinc Dry Basis	97	mg/kg	6010B	04/28/2005
CP/AA Batch#/Digest Date	1263		3050B-M	04/26/2005
CPMS Batch#/Digest Date	1267		3050B-SE	04/29/2005
Mercury Batch #/Digest Date	1267		3050B-HG	04/29/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-28 Description: TP-168A Matrix: SOIL
 Date Received: 04/22/2005
 Date Collected: 04/18/2005 Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<5	mg/kg	6020	05/03/2005
Arsenic Dry Basis	37	mg/kg	6010B	04/28/2005
Barium Dry Basis	50	mg/kg	6010B	04/28/2005
Cadmium Dry Basis	<2	mg/kg	6010B	04/28/2005
Chromium Dry Basis	11	mg/kg	6010B	04/28/2005
Copper Dry Basis	19	mg/kg	6010B	04/28/2005
Iron Dry Basis	15,600	mg/kg	6010B	05/02/2005
Lead Dry Basis	37	mg/kg	6010B	04/28/2005
Manganese Dry Basis	338	mg/kg	6010B	04/28/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	8	mg/kg	6010B	04/28/2005
Silver Dry Basis	<5	mg/kg	6010B	04/28/2005
Zinc Dry Basis	62	mg/kg	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1263	----	3050B-M	04/26/2005
ICPMS Batch#/Digest Date	1267	----	3050B-SB	04/29/2005
Mercury Batch #/Digest Date	1267	----	3050B-HG	04/29/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-29 Description: TP-168B Matrix: SOIL

Date Received: 04/22/2005

Date Collected: 04/18/2005 Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<5	mg/kg	6020	05/03/2005
Arsenic Dry Basis	21	mg/kg	6010B	04/28/2005
Barium Dry Basis	58	mg/kg	6010B	04/28/2005
Cadmium Dry Basis	<2	mg/kg	6010B	04/28/2005
Chromium Dry Basis	8	mg/kg	6010B	04/28/2005
Copper Dry Basis	12	mg/kg	6010B	04/28/2005
Iron Dry Basis	13,200	mg/kg	6010B	05/02/2005
Lead Dry Basis	30	mg/kg	6010B	04/28/2005
Manganese Dry Basis	644	mg/kg	6010B	04/28/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	<5	mg/kg	6010B	04/28/2005
Silver Dry Basis	<5	mg/kg	6010B	04/28/2005
Zinc Dry Basis	48	mg/kg	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1263	-----	3050B-M	04/26/2005
ICPMS Batch#/Digest Date	1267	-----	3050B-SB	04/29/2005
Mercury Batch #/Digest Date	1267	-----	3050B-HG	04/29/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-30 Description: TP-168C Matrix: SOIL
 Date Received: 04/22/2005
 Date Collected: 04/18/2005 Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<5	mg/kg	6020	05/03/2005
Arsenic Dry Basis	110	mg/kg	6010B	04/28/2005
Barium Dry Basis	123	mg/kg	6010B	04/28/2005
Cadmium Dry Basis	<2	mg/kg	6010B	04/28/2005
Chromium Dry Basis	13	mg/kg	6010B	04/28/2005
Copper Dry Basis	49	mg/kg	6010B	04/28/2005
Iron Dry Basis	21,500	mg/kg	6010B	05/02/2005
Lead Dry Basis	108	mg/kg	6010B	04/28/2005
Manganese Dry Basis	1030	mg/kg	6010B	04/28/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	10	mg/kg	6010B	04/28/2005
Silver Dry Basis	<5	mg/kg	6010B	04/28/2005
Zinc Dry Basis	136	mg/kg	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1263	-----	3050B-M	04/26/2005
ICPMS Batch#/Digest Date	1267	-----	3050B-SB	04/29/2005
Mercury Batch #/Digest Date	1267	-----	3050B-HG	04/29/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-31

Description: TP-169A

Matrix: SOIL

Date Received: 04/22/2005

Date Collected: 04/18/2005

Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	11	mg/kg	6020	05/03/2005
Arsenic Dry Basis	70	mg/kg	6010B	04/28/2005
Barium Dry Basis	202	mg/kg	6010B	04/28/2005
Cadmium Dry Basis	6	mg/kg	6010B	04/28/2005
Chromium Dry Basis	13	mg/kg	6010B	04/28/2005
Copper Dry Basis	103	mg/kg	6010B	04/28/2005
Iron Dry Basis	19,100	mg/kg	6010B	05/02/2005
Lead Dry Basis	590	mg/kg	6010B	04/28/2005
Manganese Dry Basis	24,700	mg/kg	6010B	04/28/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	7	mg/kg	6010B	04/28/2005
Silver Dry Basis	7	mg/kg	6010B	04/28/2005
Zinc Dry Basis	1050	mg/kg	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1263	----	3050B-M	04/26/2005
CPMS Batch#/Digest Date	1267	----	3050B-SB	04/29/2005
Mercury Batch #/Digest Date	1267	----	3050B-HG	04/29/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-32	Description: TP-169B	Matrix: SOIL
Date Received: 04/22/2005		
Date Collected: 04/18/2005	Collected by: JOE FAUBION	

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
INORGANICS				
Chloride (Water Soluble)	<20	mg/kg	3c MOD	04/29/2005
Hardness as CaCO3	162J	mg/l	2340B	05/13/2005
Cation Exchange Capacity	7.8	meq/100g	19 ASA	05/12/2005
Electrical Conductivity Saturated Paste	0.34	mmhos/cm	3a	04/29/2005
pH Saturated Paste	7.9	S.U.	21(a) ASA	04/29/2005
Calcium saturated paste	2.25J	meq/l	6010B	05/13/2005
Magnesium saturated paste	0.99J	meq/l	6010B	05/13/2005
Sulfate Water Soluble Dry Basis	<0.01	%	10-3.7MOD	04/29/2005
PARTICLE SIZE ANALYSIS				
Sand	67.5	%	42b mod.	05/03/2005
Silt	23.7	%	42b mod.	05/03/2005
Clay	8.8	%	42b mod.	05/03/2005
Texture	Sandy Loam		42b mod.	05/03/2005
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	10	mg/kg	6020	05/03/2005
Arsenic Dry Basis	609	mg/kg	6010B	04/28/2005
Barium Dry Basis	200	mg/kg	6010B	04/28/2005
Cadmium Dry Basis	5	mg/kg	6010B	04/28/2005
Chromium Dry Basis	15	mg/kg	6010B	04/28/2005
Copper Dry Basis	92	mg/kg	6010B	04/28/2005
Iron Dry Basis	21,300	mg/kg	6010B	05/02/2005
Lead Dry Basis	496	mg/kg	6010B	04/28/2005
Manganese Dry Basis	22,800	mg/kg	6010B	04/28/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	7	mg/kg	6010B	04/28/2005
Silver Dry Basis	5	mg/kg	6010B	04/28/2005
Zinc Dry Basis	911	mg/kg	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1263	----	3050B-M	04/26/2005
ICPMS Batch#/Digest Date	1267	----	3050B-SB	04/29/2005
Mercury Batch #/Digest Date	1267	----	3050B-HG	04/29/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-33	Description: TP-170A	Matrix: SOIL
Date Received: 04/22/2005		
Date Collected: 04/19/2005	Collected by: JOE FAUBION	

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
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TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<5	mg/kg	6020	05/03/2005
Arsenic Dry Basis	<10	mg/kg	6010B	04/28/2005
Barium Dry Basis	46	mg/kg	6010B	04/28/2005
Cadmium Dry Basis	<2	mg/kg	6010B	04/28/2005
Chromium Dry Basis	13	mg/kg	6010B	04/28/2005
Copper Dry Basis	19	mg/kg	6010B	04/28/2005
Iron Dry Basis	16,300	mg/kg	6010B	05/02/2005
Lead Dry Basis	18	mg/kg	6010B	04/28/2005
Manganese Dry Basis	340	mg/kg	6010B	04/28/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	7	mg/kg	6010B	04/28/2005
Silver Dry Basis	<5	mg/kg	6010B	04/28/2005
Zinc Dry Basis	52	mg/kg	6010B	04/28/2005
CP/AA Batch#/Digest Date	1263	-----	3050B-M	04/26/2005
CPMS Batch#/Digest Date	1267	-----	3050B-SB	04/29/2005
Mercury Batch #/Digest Date	1267	-----	3050B-HG	04/29/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-34 Description: TP-170B Matrix: SOIL
 Date Received: 04/22/2005
 Date Collected: 04/19/2005 Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	47	mg/kg	6020	05/03/2005
Arsenic Dry Basis	<50	mg/kg	6010B	05/02/2005
Barium Dry Basis	78	mg/kg	6010B	04/28/2005
Cadmium Dry Basis	<10	mg/kg	6010B	05/02/2005
Chromium Dry Basis	32	mg/kg	6010B	04/28/2005
Copper Dry Basis	99	mg/kg	6010B	04/28/2005
Iron Dry Basis	103,000	mg/kg	6010B	05/02/2005
Lead Dry Basis	567	mg/kg	6010B	04/28/2005
Manganese Dry Basis	952	mg/kg	6010B	04/28/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	22	mg/kg	6010B	04/28/2005
Silver Dry Basis	<25	mg/kg	6010B	05/02/2005
Zinc Dry Basis	78	mg/kg	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1263	----	3050B-M	04/26/2005
ICPMS Batch#/Digest Date	1267	----	3050B-SB	04/29/2005
Mercury Batch #/Digest Date	1267	----	3050B-HG	04/29/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-35

Description: TP-170C

Matrix: SOIL

Date Received: 04/22/2005

Date Collected: 04/19/2005

Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<5	mg/kg	6020	05/03/2005
Arsenic Dry Basis	61	mg/kg	6010B	04/28/2005
Barium Dry Basis	140	mg/kg	6010B	04/28/2005
Cadmium Dry Basis	<2	mg/kg	6010B	04/28/2005
Chromium Dry Basis	10	mg/kg	6010B	04/28/2005
Copper Dry Basis	29	mg/kg	6010B	04/28/2005
Iron Dry Basis	14,900	mg/kg	6010B	05/02/2005
Lead Dry Basis	60	mg/kg	6010B	04/28/2005
Manganese Dry Basis	444	mg/kg	6010B	04/28/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	7	mg/kg	6010B	04/28/2005
Silver Dry Basis	<5	mg/kg	6010B	04/28/2005
Zinc Dry Basis	83	mg/kg	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1263	----	3050B-M	04/26/2005
ICPMS Batch#/Digest Date	1267	----	3050B-SB	04/29/2005
Mercury Batch #/Digest Date	1267	----	3050B-HG	04/29/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-36

Description: TP-171A

Matrix: SOIL

Date Received: 04/22/2005

Date Collected: 04/19/2005

Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	280	mg/kg	6020	05/03/2005
Arsenic Dry Basis	33.700	mg/kg	6010B	05/02/2005
Barium Dry Basis	581	mg/kg	6010B	04/28/2005
Cadmium Dry Basis	78	mg/kg	6010B	05/02/2005
Chromium Dry Basis	17	mg/kg	6010B	04/28/2005
Copper Dry Basis	1290	mg/kg	6010B	04/28/2005
Iron Dry Basis	61,200	mg/kg	6010B	05/02/2005
Lead Dry Basis	16,300	mg/kg	6010B	05/02/2005
Manganese Dry Basis	60,000	mg/kg	6010B	04/28/2005
Mercury Dry Basis	2.1	mg/kg	6020A	05/02/2005
Nickel Dry Basis	<5	mg/kg	6010B	04/28/2005
Silver Dry Basis	106	mg/kg	6010B	05/02/2005
Zinc Dry Basis	5940	mg/kg	6010B	05/02/2005
ICP/AA Batch#/Digest Date	1263	----	3050B-M	04/26/2005
ICPMS Batch#/Digest Date	1267	----	3050B-SB	04/29/2005
Mercury Batch #/Digest Date	1267	----	3050B-HG	04/29/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-37 Description: TP-171B Matrix: SOIL
Date Received: 04/22/2005
Date Collected: 04/19/2005 Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<5	mg/kg	6020	05/03/2005
Arsenic Dry Basis	59	mg/kg	6010B	05/02/2005
Barium Dry Basis	98	mg/kg	6010B	04/28/2005
Cadmium Dry Basis	<10	mg/kg	6010B	05/02/2005
Chromium Dry Basis	21	mg/kg	6010B	04/28/2005
Copper Dry Basis	46	mg/kg	6010B	04/28/2005
Iron Dry Basis	71,900	mg/kg	6010B	05/02/2005
Lead Dry Basis	60	mg/kg	6010B	04/28/2005
Manganese Dry Basis	1260	mg/kg	6010B	04/28/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	17	mg/kg	6010B	04/28/2005
Silver Dry Basis	<25	mg/kg	6010B	05/02/2005
Zinc Dry Basis	92	mg/kg	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1263	----	3050B-M	04/26/2005
ICPMS Batch#/Digest Date	1267	-----	3050B-SB	04/29/2005
Mercury Batch #/Digest Date	1267	-----	3050B-HG	04/29/2005

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Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-38 Description: TP-171C Matrix: SOIL
 Date Received: 04/22/2005
 Date Collected: 04/19/2005 Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<5	mg/kg	6020	05/03/2005
Arsenic Dry Basis	43	mg/kg	6010B	04/28/2005
Barium Dry Basis	142	mg/kg	6010B	04/28/2005
Cadmium Dry Basis	<2	mg/kg	6010B	04/28/2005
Chromium Dry Basis	12	mg/kg	6010B	04/28/2005
Copper Dry Basis	24	mg/kg	6010B	04/28/2005
Iron Dry Basis	16,400	mg/kg	6010B	05/02/2005
Lead Dry Basis	31	mg/kg	6010B	04/28/2005
Manganese Dry Basis	305	mg/kg	6010B	04/28/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	9	mg/kg	6010B	04/28/2005
Silver Dry Basis	<5	mg/kg	6010B	04/28/2005
Zinc Dry Basis	53	mg/kg	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1263	-----	3050B-M	04/26/2005
ICPMS Batch#/Digest Date	1267	-----	3050B-SB	04/29/2005
Mercury Batch #/Digest Date	1267	-----	3050B-HG	04/29/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSR1

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-39 Description: TP-172A Matrix: SOIL

Date Received: 04/22/2005

Date Collected: 04/19/2005 Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<5	mg/kg	6020	05/03/2005
Arsenic Dry Basis	30	mg/kg	6010B	04/28/2005
Barium Dry Basis	64	mg/kg	6010B	04/28/2005
Cadmium Dry Basis	<2	mg/kg	6010B	04/28/2005
Chromium Dry Basis	10	mg/kg	6010B	04/28/2005
Copper Dry Basis	21	mg/kg	6010B	04/28/2005
Iron Dry Basis	15,000	mg/kg	6010B	05/02/2005
Lead Dry Basis	52	mg/kg	6010B	04/28/2005
Manganese Dry Basis	333	mg/kg	6010B	04/28/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	6	mg/kg	6010B	04/28/2005
Silver Dry Basis	<5	mg/kg	6010B	04/28/2005
Zinc Dry Basis	76	mg/kg	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1263	----	3050B-M	04/26/2005
ICPMS Batch#/Digest Date	1267	----	3050B-SB	04/29/2005
Mercury Batch #/Digest Date	1267	----	3050B-HG	04/29/2005

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Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-40 Description: TP-173A Matrix: SOIL
Date Received: 04/22/2005
Date Collected: 04/19/2005 Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	9	mg/kg	6020	05/03/2005
Arsenic Dry Basis	158	mg/kg	6010B	04/28/2005
Barium Dry Basis	773	mg/kg	6010B	04/28/2005
Cadmium Dry Basis	14	mg/kg	6010B	04/28/2005
Chromium Dry Basis	48	mg/kg	6010B	04/28/2005
Copper Dry Basis	350	mg/kg	6010B	04/28/2005
Iron Dry Basis	18,000	mg/kg	6010B	05/02/2005
Lead Dry Basis	1290	mg/kg	6010B	04/28/2005
Manganese Dry Basis	224,000	mg/kg	6010B	04/28/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	<5	mg/kg	6010B	04/28/2005
Silver Dry Basis	31	mg/kg	6010B	04/28/2005
Zinc Dry Basis	3370	mg/kg	6010B	05/02/2005
ICP/AA Batch#/Digest Date	1263	-----	3050B-M	04/26/2005
ICPMS Batch#/Digest Date	1267	-----	3050B-SB	04/29/2005
Mercury Batch #/Digest Date	1267	-----	3050B-HG	04/29/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-41

Description: TP-173B

Matrix: SOIL

Date Received: 04/22/2005

Date Collected: 04/19/2005

Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	21	mg/kg	6020	05/03/2005
Arsenic Dry Basis	1240	mg/kg	6010B	04/28/2005
Barium Dry Basis	343	mg/kg	6010B	05/03/2005
Cadmium Dry Basis	264	mg/kg	6010B	04/28/2005
Chromium Dry Basis	24	mg/kg	6010B	04/28/2005
Copper Dry Basis	253	mg/kg	6010B	05/03/2005
Iron Dry Basis	53,100	mg/kg	6010B	05/02/2005
Lead Dry Basis	3010	mg/kg	6010B	04/28/2005
Manganese Dry Basis	36,900	mg/kg	6010B	04/28/2005
Mercury Dry Basis	0.7	mg/kg	6020A	05/02/2005
Nickel Dry Basis	11	mg/kg	6010B	04/28/2005
Silver Dry Basis	15	mg/kg	6010B	04/28/2005
Zinc Dry Basis	48,400	mg/kg	6010B	05/02/2005
ICP/AA Batch#/Digest Date	1264	-----	3050B-M	04/27/2005
CPMS Batch#/Digest Date	1268	-----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1268	-----	3050B-HG	04/28/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-42 Description: TP-173C Matrix: SOIL

Date Received: 04/22/2005

Date Collected: 04/19/2005 Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<5	mg/kg	6020	05/03/2005
Arsenic Dry Basis	54	mg/kg	6010B	04/28/2005
Barium Dry Basis	172	mg/kg	6010B	05/03/2005
Cadmium Dry Basis	<2	mg/kg	6010B	04/28/2005
Chromium Dry Basis	10	mg/kg	6010B	04/28/2005
Copper Dry Basis	22	mg/kg	6010B	05/03/2005
Iron Dry Basis	15,000	mg/kg	6010B	05/02/2005
Lead Dry Basis	27	mg/kg	6010B	04/28/2005
Manganese Dry Basis	448	mg/kg	6010B	04/28/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	9	mg/kg	6010B	04/28/2005
Silver Dry Basis	<5	mg/kg	6010B	04/28/2005
Zinc Dry Basis	93	mg/kg	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1264	----	3050B-M	04/27/2005
ICPMS Batch#/Digest Date	1268	----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1268	----	3050B-HG	04/28/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-43

Description: TP-174A

Matrix: SOIL

Date Received: 04/22/2005

Date Collected: 04/19/2005

Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<5	mg/kg	6020	05/03/2005
Arsenic Dry Basis	76	mg/kg	6010B	04/28/2005
Barium Dry Basis	180	mg/kg	6010B	05/03/2005
Cadmium Dry Basis	4	mg/kg	6010B	04/28/2005
Chromium Dry Basis	17	mg/kg	6010B	04/28/2005
Copper Dry Basis	53	mg/kg	6010B	05/03/2005
Iron Dry Basis	19,300	mg/kg	6010B	05/02/2005
Lead Dry Basis	298	mg/kg	6010B	04/28/2005
Manganese Dry Basis	18,000	mg/kg	6010B	04/28/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	9	mg/kg	6010B	04/28/2005
Silver Dry Basis	<5	mg/kg	6010B	04/28/2005
Zinc Dry Basis	1050	mg/kg	6010B	04/28/2005
CP AA Batch#/Digest Date	1264	-----	3050B-M	04/27/2005
CPMS Batch#/Digest Date	1268	-----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1268	-----	3050B-HG	04/28/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-44 Description: TP-174B Matrix: SOIL

Date Received: 04/22/2005

Date Collected: 04/19/2005 Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<5	mg/kg	6020	05/03/2005
Arsenic Dry Basis	65	mg/kg	6010B	04/28/2005
Barium Dry Basis	79	mg/kg	6010B	05/03/2005
Cadmium Dry Basis	<2	mg/kg	6010B	04/28/2005
Chromium Dry Basis	11	mg/kg	6010B	04/28/2005
Copper Dry Basis	24	mg/kg	6010B	05/03/2005
Iron Dry Basis	17,800	mg/kg	6010B	05/02/2005
Lead Dry Basis	55	mg/kg	6010B	04/28/2005
Manganese Dry Basis	391	mg/kg	6010B	04/28/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	8	mg/kg	6010B	04/28/2005
Silver Dry Basis	<5	mg/kg	6010B	04/28/2005
Zinc Dry Basis	80	mg/kg	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1264	----	3050B-M	04/27/2005
ICPMS Batch#/Digest Date	1268	----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1268	----	3050B-HG	04/28/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-45

Description: TP-174C

Matrix: SOIL

Date Received: 04/22/2005

Date Collected: 04/19/2005

Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<5	mg/kg	6020	05/03/2005
Arsenic Dry Basis	11	mg/kg	6010B	04/28/2005
Barium Dry Basis	79	mg/kg	6010B	05/03/2005
Cadmium Dry Basis	<2	mg/kg	6010B	04/28/2005
Chromium Dry Basis	10	mg/kg	6010B	04/28/2005
Copper Dry Basis	65	mg/kg	6010B	05/03/2005
Iron Dry Basis	32,600	mg/kg	6010B	05/02/2005
Lead Dry Basis	84	mg/kg	6010B	04/28/2005
Manganese Dry Basis	396	mg/kg	6010B	04/28/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	12	mg/kg	6010B	04/28/2005
Silver Dry Basis	<5	mg/kg	6010B	04/28/2005
Zinc Dry Basis	69	mg/kg	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1264	----	3050B-M	04/27/2005
ICPMS Batch#/Digest Date	1268	----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1268	----	3050B-HG	04/28/2005

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Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-46 Description: TP-174D Matrix: SOIL
 Date Received: 04/22/2005
 Date Collected: 04/19/2005 Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<5	mg/kg	6020	05/03/2005
Arsenic Dry Basis	39	mg/kg	6010B	04/28/2005
Barium Dry Basis	127	mg/kg	6010B	05/03/2005
Cadmium Dry Basis	<2	mg/kg	6010B	04/28/2005
Chromium Dry Basis	13	mg/kg	6010B	04/28/2005
Copper Dry Basis	22	mg/kg	6010B	05/03/2005
Iron Dry Basis	18,200	mg/kg	6010B	05/02/2005
Lead Dry Basis	33	mg/kg	6010B	04/28/2005
Manganese Dry Basis	407	mg/kg	6010B	04/28/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	9	mg/kg	6010B	04/28/2005
Silver Dry Basis	<5	mg/kg	6010B	04/28/2005
Zinc Dry Basis	89	mg/kg	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1264	----	3050B-M	04/27/2005
ICPMS Batch#/Digest Date	1268	----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1268	----	3050B-HG	04/28/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-47

Description: SD-201

Matrix: SOIL

Date Received: 04/22/2005

Date Collected: 04/21/2005

Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
ORGANICS				
Organic Carbon dry basis	2.0 J	%	24	04/29/2005
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<5	mg/kg	6020	05/03/2005
Arsenic Dry Basis	95	mg/kg	6010B	04/28/2005
Barium Dry Basis	77	mg/kg	6010B	05/03/2005
Cadmium Dry Basis	<2	mg/kg	6010B	04/28/2005
Chromium Dry Basis	8	mg/kg	6010B	04/28/2005
Copper Dry Basis	25	mg/kg	6010B	05/03/2005
Iron Dry Basis	10.800	mg/kg	6010B	05/02/2005
Lead Dry Basis	135	mg/kg	6010B	04/28/2005
Manganese Dry Basis	3650	mg/kg	6010B	04/28/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	<5	mg/kg	6010B	04/28/2005
Silver Dry Basis	<5	mg/kg	6010B	04/28/2005
Zinc Dry Basis	193	mg/kg	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1264	----	3050B-M	04/27/2005
CPMS Batch#/Digest Date	1268	-----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1268	-----	3050B-HG	04/28/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-48 Description: SD-202 Matrix: SOIL
 Date Received: 04/22/2005
 Date Collected: 04/21/2005 Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
ORGANICS				
Organic Carbon dry basis	1.6	%	24	04/29/2005
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<5	mg/kg	6020	05/03/2005
Arsenic Dry Basis	34	mg/kg	6010B	04/28/2005
Barium Dry Basis	54	mg/kg	6010B	05/03/2005
Cadmium Dry Basis	<2	mg/kg	6010B	04/28/2005
Chromium Dry Basis	7	mg/kg	6010B	04/28/2005
Copper Dry Basis	19	mg/kg	6010B	05/03/2005
Iron Dry Basis	9550	mg/kg	6010B	04/28/2005
Lead Dry Basis	53	mg/kg	6010B	04/28/2005
Manganese Dry Basis	384	mg/kg	6010B	04/28/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	<5	mg/kg	6010B	04/28/2005
Silver Dry Basis	<5	mg/kg	6010B	04/28/2005
Zinc Dry Basis	83	mg/kg	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1264	----	3050B-M	04/27/2005
ICPMS Batch#/Digest Date	1268	----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1268	----	3050B-HG	04/28/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-49 Description: SD-203 Matrix: SOIL

Date Received: 04/22/2005

Date Collected: 04/21/2005 Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
ORGANICS				
Organic Carbon dry basis	1.4	%	24	04/29/2005
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<5	mg/kg	6020	05/03/2005
Arsenic Dry Basis	19	mg/kg	6010B	04/28/2005
Barium Dry Basis	52	mg/kg	6010B	05/03/2005
Cadmium Dry Basis	<2	mg/kg	6010B	04/28/2005
Chromium Dry Basis	10	mg/kg	6010B	04/28/2005
Copper Dry Basis	15	mg/kg	6010B	05/03/2005
Iron Dry Basis	9840	mg/kg	6010B	04/28/2005
Lead Dry Basis	64	mg/kg	6010B	04/28/2005
Manganese Dry Basis	159	mg/kg	6010B	04/28/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	<5	mg/kg	6010B	04/28/2005
Silver Dry Basis	<5	mg/kg	6010B	04/28/2005
Zinc Dry Basis	82	mg/kg	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1264	----	3050B-M	04/27/2005
CPMS Batch#/Digest Date	1268	----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1268	----	3050B-HG	04/28/2005

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Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-50	Description: SD-204	Matrix: SOIL
Date Received: 04/22/2005		
Date Collected: 04/21/2005	Collected by: JOE FAUBION	

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
ORGANICS				
Organic Carbon dry basis	2.8	%	24	04/29/2005
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<5	mg/kg	6020	05/03/2005
Arsenic Dry Basis	32	mg/kg	6010B	04/28/2005
Barium Dry Basis	116	mg/kg	6010B	05/03/2005
Cadmium Dry Basis	<2	mg/kg	6010B	04/28/2005
Chromium Dry Basis	10	mg/kg	6010B	04/28/2005
Copper Dry Basis	42	mg/kg	6010B	05/03/2005
Iron Dry Basis	9560	mg/kg	6010B	04/28/2005
Lead Dry Basis	163	mg/kg	6010B	04/28/2005
Manganese Dry Basis	586	mg/kg	6010B	04/28/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	<5	mg/kg	6010B	04/28/2005
Silver Dry Basis	<5	mg/kg	6010B	04/28/2005
Zinc Dry Basis	218	mg/kg	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1264	-----	3050B-M	04/27/2005
ICPMS Batch#/Digest Date	1268	-----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1268	-----	3050B-HG	04/28/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-51 Description: SD-205 Matrix: SOIL

Date Received: 04/22/2005

Date Collected: 04/21/2005 Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
ORGANICS				
Organic Carbon dry basis	3.3	%	24	04/29/2005
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<5	mg/kg	6020	05/03/2005
Arsenic Dry Basis	31	mg/kg	6010B	04/28/2005
Barium Dry Basis	120	mg/kg	6010B	05/03/2005
Cadmium Dry Basis	<2	mg/kg	6010B	04/28/2005
Chromium Dry Basis	10	mg/kg	6010B	04/28/2005
Copper Dry Basis	38	mg/kg	6010B	05/03/2005
Iron Dry Basis	14,300	mg/kg	6010B	05/02/2005
Lead Dry Basis	130	mg/kg	6010B	04/28/2005
Manganese Dry Basis	323	mg/kg	6010B	04/28/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	7	mg/kg	6010B	04/28/2005
Silver Dry Basis	<5	mg/kg	6010B	04/28/2005
Zinc Dry Basis	185	mg/kg	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1264	----	3050B-M	04/27/2005
ICPMS Batch#/Digest Date	1268	----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1268	----	3050B-HG	04/28/2005

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Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-52	Description: SD-206	Matrix: SOIL
Date Received: 04/22/2005		
Date Collected: 04/21/2005	Collected by: JOE FAUBION	

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
ORGANICS				
Organic Carbon dry basis	2.6	%	24	04/29/2005
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<5	mg/kg	6020	05/03/2005
Arsenic Dry Basis	20	mg/kg	6010B	04/28/2005
Barium Dry Basis	98	mg/kg	6010B	05/03/2005
Cadmium Dry Basis	<2	mg/kg	6010B	04/28/2005
Chromium Dry Basis	6	mg/kg	6010B	04/28/2005
Copper Dry Basis	24	mg/kg	6010B	05/03/2005
Iron Dry Basis	6420	mg/kg	6010B	04/28/2005
Lead Dry Basis	70	mg/kg	6010B	04/28/2005
Manganese Dry Basis	173	mg/kg	6010B	04/28/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	<5	mg/kg	6010B	04/28/2005
Silver Dry Basis	<5	mg/kg	6010B	04/28/2005
Zinc Dry Basis	93	mg/kg	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1264	-----	3050B-M	04/27/2005
ICPMS Batch#/Digest Date	1268	-----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1268	-----	3050B-HG	04/28/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-53 Description: SD-207 Matrix: SOIL

Date Received: 04/22/2005

Date Collected: 04/21/2005 Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
ORGANICS				
Organic Carbon dry basis	9.2	%	24	04/29/2005
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<5	mg/kg	6020	05/03/2005
Arsenic Dry Basis	105	mg/kg	6010B	04/28/2005
Barium Dry Basis	121	mg/kg	6010B	05/03/2005
Cadmium Dry Basis	<2	mg/kg	6010B	04/28/2005
Chromium Dry Basis	5	mg/kg	6010B	04/28/2005
Copper Dry Basis	39	mg/kg	6010B	05/03/2005
Iron Dry Basis	6940	mg/kg	6010B	04/28/2005
Lead Dry Basis	70	mg/kg	6010B	04/28/2005
Manganese Dry Basis	814	mg/kg	6010B	04/28/2005
Mercury Dry Basis	<0.5	mg/kg	6020A	05/02/2005
Nickel Dry Basis	<5	mg/kg	6010B	04/28/2005
Silver Dry Basis	<5	mg/kg	6010B	04/28/2005
Zinc Dry Basis	314	mg/kg	6010B	04/28/2005
CP/AA Batch#/Digest Date	1264	----	3050B-M	04/27/2005
CPMS Batch#/Digest Date	1268	----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1268	----	3050B-HG	04/28/2005

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Client Name: MT DEPT OF ENVIROMENTAL QUALITY**Project No.:** S1129-30SMLSRI**Project Name:** SPRING MEADOW LAKE

Sample No.: 2005040193-54	Description: SD-208	Matrix: SOIL
Date Received: 04/22/2005		
Date Collected: 04/21/2005	Collected by: JOE FAUBION	

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
ORGANICS				
Organic Carbon dry basis	5.0	%	24	04/29/2005
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<5	mg/kg	6020	05/03/2005
Arsenic Dry Basis	110	mg/kg	6010B	04/28/2005
Barium Dry Basis	130	mg/kg	6010B	05/03/2005
Cadmium Dry Basis	6	mg/kg	6010B	04/28/2005
Chromium Dry Basis	13	mg/kg	6010B	04/28/2005
Copper Dry Basis	78	mg/kg	6010B	05/03/2005
Iron Dry Basis	14,800	mg/kg	6010B	05/02/2005
Lead Dry Basis	319	mg/kg	6010B	04/28/2005
Manganese Dry Basis	1370	mg/kg	6010B	04/28/2005
Mercury Dry Basis	0.6	mg/kg	6020A	05/02/2005
Nickel Dry Basis	7	mg/kg	6010B	04/28/2005
Silver Dry Basis	<5	mg/kg	6010B	04/28/2005
Zinc Dry Basis	619	mg/kg	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1264	----	3050B-M	04/27/2005
ICPMS Batch#/Digest Date	1268	----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1268	----	3050B-HG	04/28/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-55	Description: MATRIX SPIKE OF	Matrix: SOIL
Date Received: 04/22/2005	2005040193-1	
Date Collected: 04/18/2005	Collected by: JOE FAUBION	

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	94	% [75-125]	6020	05/03/2005
Arsenic Dry Basis	101	% [75-125]	6010B	04/28/2005
Barium Dry Basis	101	% [75-125]	6010B	04/28/2005
Cadmium Dry Basis	99	% [75-125]	6010B	04/28/2005
Chromium Dry Basis	96	% [75-125]	6010B	04/28/2005
Copper Dry Basis	106	% [75-125]	6010B	04/28/2005
Iron Dry Basis	(2)	% [75-125]	6010B	05/02/2005
Lead Dry Basis	97	% [75-125]	6010B	04/28/2005
Manganese Dry Basis	(2)	% [75-125]	6010B	05/02/2005
Mercury Dry Basis	100	% [75-125]	6020A	05/02/2005
Nickel Dry Basis	100	% [75-125]	6010B	04/28/2005
Silver Dry Basis	103	% [75-125]	6010B	04/28/2005
Zinc Dry Basis	94	% [75-125]	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1262	----	3050B-M	04/26/2005
ICPMS Batch#/Digest Date	1265	----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1265	----	3050B-HG	04/28/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-56 Description: MATRIX SPIKE DUPLICATE OF Matrix: SOIL
 Date Received: 04/22/2005 2005040193-1
 Date Collected: 04/18/2005 Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	1	RPD [0-20]	6020	05/03/2005
Arsenic Dry Basis	1	RPD [0-20]	6010B	04/28/2005
Barium Dry Basis	3	RPD [0-20]	6010B	04/28/2005
Cadmium Dry Basis	2	RPD [0-20]	6010B	04/28/2005
Chromium Dry Basis	0	RPD [0-20]	6010B	04/28/2005
Copper Dry Basis	2	RPD [0-20]	6010B	04/28/2005
Iron Dry Basis	17	RPD [0-20]	6010B	05/02/2005
Lead Dry Basis	3	RPD [0-20]	6010B	04/28/2005
Manganese Dry Basis	(2)	RPD [0-20]	6010B	05/02/2005
Mercury Dry Basis	3	RPD [0-20]	6020A	05/02/2005
Nickel Dry Basis	2	RPD [0-20]	6010B	04/28/2005
Silver Dry Basis	2	RPD [0-20]	6010B	04/28/2005
Zinc Dry Basis	1	RPD [0-20]	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1262	-----	3050B-M	04/26/2005
ICPMS Batch#/Digest Date	1265	-----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1265	-----	3050B-HG	04/28/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-57 Description: SOIL LAB CONTROL SAMPLE Matrix: SOIL

Date Received: ----

Date Collected: ---- Collected by: PREPARED BY LAB

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	80	% [10-223]	6020	05/03/2005
Arsenic Dry Basis	97	% [79-121]	6010B	04/28/2005
Barium Dry Basis	99	% [80-120]	6010B	04/28/2005
Cadmium Dry Basis	97	% [80-120]	6010B	04/28/2005
Chromium Dry Basis	98	% [79-122]	6010B	04/28/2005
Copper Dry Basis	99	% [82-118]	6010B	04/28/2005
Iron Dry Basis	102	% [57-143]	6010B	05/02/2005
Lead Dry Basis	100	% [79-121]	6010B	04/28/2005
Manganese Dry Basis	97	% [80-120]	6010B	04/28/2005
Mercury Dry Basis	87	% [59-141]	6020A	05/02/2005
Nickel Dry Basis	99	% [82-118]	6010B	04/28/2005
Silver Dry Basis	102	% [61-138]	6010B	04/28/2005
Zinc Dry Basis	98	% [79-121]	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1262	----	3050B-M	04/26/2005
ICPMS Batch#/Digest Date	1265	----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1265	----	3050B-HG	04/28/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-58 Description: AQUEOUS LAB CONTROL Matrix: WATER
 Date Received: ----- SAMPLE
 Date Collected: ----- Collected by: PREPARED BY LAB

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	92	% [80-120]	6020	05/03/2005
Arsenic Dry Basis	104	% [80-120]	6010B	04/28/2005
Barium Dry Basis	104	% [80-120]	6010B	04/28/2005
Cadmium Dry Basis	102	% [80-120]	6010B	04/28/2005
Chromium Dry Basis	102	% [80-120]	6010B	04/28/2005
Copper Dry Basis	104	% [80-120]	6010B	04/28/2005
Iron Dry Basis	102	% [80-120]	6010B	05/02/2005
Lead Dry Basis	106	% [80-120]	6010B	04/28/2005
Manganese Dry Basis	104	% [80-120]	6010B	04/28/2005
Mercury Dry Basis	99	% [80-120]	6020A	05/02/2005
Nickel Dry Basis	104	% [80-120]	6010B	04/28/2005
Silver Dry Basis	104	% [80-120]	6010B	04/28/2005
Zinc Dry Basis	93	% [80-120]	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1262	-----	3050B-M	04/26/2005
ICPMS Batch#/Digest Date	1265	-----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1265	-----	3050B-HG	04/28/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-59 Description: METHOD BLANK Matrix: WATER

Date Received: ----

Date Collected: ---- Collected by: PREPARED BY LAB

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<0.05	mg/l	6020	05/03/2005
Arsenic Dry Basis	<0.1	mg/l	6010B	04/28/2005
Barium Dry Basis	<0.05	mg/l	6010B	04/28/2005
Cadmium Dry Basis	<0.02	mg/l	6010B	04/28/2005
Chromium Dry Basis	<0.02	mg/l	6010B	04/28/2005
Copper Dry Basis	<0.1	mg/l	6010B	04/28/2005
Iron Dry Basis	<0.1	mg/l	6010B	05/02/2005
Lead Dry Basis	<0.1	mg/l	6010B	04/28/2005
Manganese Dry Basis	<0.02	mg/l	6010B	04/28/2005
Mercury Dry Basis	<0.005	mg/l	6020A	05/02/2005
Nickel Dry Basis	<0.05	mg/l	6010B	04/28/2005
Silver Dry Basis	<0.05	mg/l	6010B	04/28/2005
Zinc Dry Basis	<0.1	mg/l	6010B	04/28/2005
CP/AA Batch#/Digest Date	1262	----	3050B-M	04/26/2005
CPMS Batch#/Digest Date	1265	----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1265	----	3050B-HG	04/28/2005

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Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-61	Description: MATRIX SPIKE OF	Matrix: SOIL
Date Received: 04/22/2005	2005040193-21	
Date Collected: 04/18/2005	Collected by: JOE FAUBION	

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	94	% [75-125]	6020	05/03/2005
Arsenic Dry Basis	88	% [75-125]	6010B	04/28/2005
Barium Dry Basis	82	% [75-125]	6010B	04/28/2005
Cadmium Dry Basis	98	% [75-125]	6010B	04/28/2005
Chromium Dry Basis	96	% [75-125]	6010B	04/28/2005
Copper Dry Basis	106	% [75-125]	6010B	04/28/2005
Iron Dry Basis	(2)	% [75-125]	6010B	05/02/2005
Lead Dry Basis	(2)	% [75-125]	6010B	04/28/2005
Manganese Dry Basis	(2)	% [75-125]	6010B	05/09/2005
Mercury Dry Basis	102	% [75-125]	6020A	05/02/2005
Nickel Dry Basis	99	% [75-125]	6010B	04/28/2005
Silver Dry Basis	106	% [75-125]	6010B	04/28/2005
Zinc Dry Basis	(2)	% [75-125]	6010B	05/02/2005
ICP/AA Batch#/Digest Date	1263	----	3050B-M	04/26/2005
ICPMS Batch#/Digest Date	1267	----	3050B-SB	04/29/2005
Mercury Batch #/Digest Date	1267	----	3050B-HG	04/29/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-62	Description: MATRIX SPIKE DUPLICATE OF	Matrix: SOIL
Date Received: 04/22/2005	2005040193-21	
Date Collected: 04/18/2005	Collected by: JOE FAUBION	

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	1	RPD [0-20]	6020	05/03/2005
Arsenic Dry Basis	1	RPD [0-20]	6010B	04/28/2005
Barium Dry Basis	3	RPD [0-20]	6010B	04/28/2005
Cadmium Dry Basis	0	RPD [0-20]	6010B	04/28/2005
Chromium Dry Basis	1	RPD [0-20]	6010B	04/28/2005
Copper Dry Basis	1	RPD [0-20]	6010B	04/28/2005
Iron Dry Basis	3	RPD [0-20]	6010B	05/02/2005
Lead Dry Basis	9	RPD [0-20]	6010B	04/28/2005
Manganese Dry Basis	7	RPD [0-20]	6010B	05/09/2005
Mercury Dry Basis	2	RPD [0-20]	6020A	05/02/2005
Nickel Dry Basis	0	RPD [0-20]	6010B	04/28/2005
Silver Dry Basis	3	RPD [0-20]	6010B	04/28/2005
Zinc Dry Basis	5	RPD [0-20]	6010B	05/02/2005
CP/AA Batch#/Digest Date	1263	-----	3050B-M	04/26/2005
CPMS Batch#/Digest Date	1267	-----	3050B-SB	04/29/2005
Mercury Batch #/Digest Date	1267	-----	3050B-HG	04/29/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-63 Description: SOIL LAB CONTROL SAMPLE Matrix: SOIL

Date Received: ----

Date Collected: ---- Collected by: PREPARED BY LAB

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
INORGANICS				
Chloride (Water Soluble)	108	% [80-120]	3c MOD	04/29/2005
Hardness as CaCO3	NA	----	----	
Cation Exchange Capacity	NA	----	----	
Electrical Conductivity Saturated Paste	139	% [48-151]	3a	04/29/2005
pH Saturated Paste	98	% [93-107]	21(a) ASA	04/29/2005
Calcium saturated paste	90	% [52-148]	6010B	05/13/2005
Magnesium saturated paste	83	% [56-144]	6010B	05/13/2005
Sulfate Water Soluble Dry Basis	105	% [84-122]	10-3.7MOD	04/29/2005
PARTICLE SIZE ANALYSIS				
Sand	96	% [72-128]	42b mod.	05/03/2005
Silt	112	% [74-126]	42b mod.	05/03/2005
Clay	130	% [65-135]	42b mod.	05/03/2005
Texture	Loam		42b mod.	05/03/2005
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	74	% [10-223]	6020	05/03/2005
Arsenic Dry Basis	103	% [79-121]	6010B	04/28/2005
Barium Dry Basis	102	% [80-120]	6010B	04/28/2005
Cadmium Dry Basis	101	% [80-120]	6010B	04/28/2005
Chromium Dry Basis	102	% [79-121]	6010B	04/28/2005
Copper Dry Basis	103	% [82-118]	6010B	04/28/2005
Iron Dry Basis	108	% [57-143]	6010B	04/28/2005
Lead Dry Basis	104	% [79-121]	6010B	04/28/2005
Manganese Dry Basis	102	% [80-120]	6010B	04/28/2005
Mercury Dry Basis	81	% [59-141]	6020A	05/02/2005
Nickel Dry Basis	102	% [82-118]	6010B	04/28/2005
Silver Dry Basis	106	% [61-138]	6010B	04/28/2005
Zinc Dry Basis	102	% [79-121]	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1263	----	3050B-M	04/26/2005
ICPMS Batch#/Digest Date	1267	----	3050B-SB	04/29/2005
Mercury Batch #/Digest Date	1267	----	3050B-HG	04/29/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-64	Description: AQUEOUS LAB CONTROL	Matrix: WATER
Date Received: -----	SAMPLE	
Date Collected: -----	Collected by: PREPARED BY LAB	

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
INORGANICS				
Chloride (Water Soluble)	100	% [80-120]	3c MOD	04/29/2005
Hardness as CaCO3	NA	-----	-----	
Cation Exchange Capacity	NA	-----	-----	-----
Electrical Conductivity Saturated Paste	99	% [90-110]	3a	04/29/2005
pH Saturated Paste	99	% [99-101]	21(a) ASA	04/29/2005
Calcium saturated paste	105	% [92-111]	6010B	05/13/2005
Magnesium saturated paste	102	% [92-115]	6010B	05/13/2005
Sulfate Water Soluble Dry Basis	103	% [94-113]	10-3.7MOD	04/29/2005
PARTICLE SIZE ANALYSIS				
Sand	NA	-----	-----	-----
Silt	NA	-----	-----	-----
Clay	NA	-----	-----	-----
Texture	NA	-----	-----	-----
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	90	% [80-120]	6020	05/03/2005
Arsenic Dry Basis	104	% [80-120]	6010B	04/28/2005
Barium Dry Basis	102	% [80-120]	6010B	04/28/2005
Cadmium Dry Basis	102	% [80-120]	6010B	04/28/2005
Chromium Dry Basis	101	% [80-120]	6010B	04/28/2005
Copper Dry Basis	103	% [80-120]	6010B	04/28/2005
Iron Dry Basis	109	% [80-120]	6010B	04/28/2005
Lead Dry Basis	104	% [80-120]	6010B	04/28/2005
Manganese Dry Basis	104	% [80-120]	6010B	04/28/2005
Mercury Dry Basis	96	% [80-120]	6020A	05/02/2005
Nickel Dry Basis	104	% [80-120]	6010B	04/28/2005
Silver Dry Basis	102	% [80-120]	6010B	04/28/2005
Zinc Dry Basis	101	% [80-120]	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1263	-----	3050B-M	04/26/2005
ICPMS Batch#/Digest Date	1267	-----	3050B-SB	04/29/2005
Mercury Batch #/Digest Date	1267	-----	3050B-HG	04/29/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-65 Description: METHOD BLANK Matrix: WATER

Date Received: -----

Date Collected: ----- Collected by: PREPARED BY LAB

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
INORGANICS				
Chloride (Water Soluble)	<20	mg/kg	3c MOD	04/29/2005
Hardness as CaCO3	<7	mg/l	2340B	05/13/2005
Cation Exchange Capacity	<0.9	meq/100g	19 ASA	05/12/2005
Electrical Conductivity Saturated Paste	<0.01	mmhos/cm	3a	04/29/2005
pH Saturated Paste	NA	----	----	----
Calcium saturated paste	<0.05	meq/l	6010B	05/13/2005
Magnesium saturated paste	<0.08	meq/l	6010B	05/13/2005
Sulfate Water Soluble Dry Basis	<0.01	%	10-3.7MOD	04/29/2005
PARTICLE SIZE ANALYSIS				
Sand	NA	----	----	----
Silt	NA	----	----	----
Clay	NA	----	----	----
Texture	NA	----	----	----
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<0.05	mg/l	6020	05/03/2005
Arsenic Dry Basis	<0.1	mg/l	6010B	04/28/2005
Barium Dry Basis	<0.05	mg/l	6010B	04/28/2005
Cadmium Dry Basis	<0.02	mg/l	6010B	04/28/2005
Chromium Dry Basis	<0.02	mg/l	6010B	04/28/2005
Copper Dry Basis	<0.1	mg/l	6010B	04/28/2005
Iron Dry Basis	<0.1	mg/l	6010B	04/28/2005
Lead Dry Basis	<0.1	mg/l	6010B	04/28/2005
Manganese Dry Basis	<0.02	mg/l	6010B	04/28/2005
Mercury Dry Basis	<0.005	mg/l	6020A	05/02/2005
Nickel Dry Basis	<0.05	mg/l	6010B	04/28/2005
Silver Dry Basis	<0.05	mg/l	6010B	04/28/2005
Zinc Dry Basis	<0.1	mg/l	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1263	----	3050B-M	04/26/2005
ICPMS Batch#/Digest Date	1267	----	3050B-SB	04/29/2005
Mercury Batch #/Digest Date	1267	----	3050B-HG	04/29/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-67	Description: MATRIX SPIKE OF	Matrix: SOIL
Date Received: 04/22/2005	2005040193-41	
Date Collected: 04/19/2005	Collected by: JOE FAUBION	

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
ORGANICS				
Organic Carbon dry basis	106	% [80-120]	24	04/29/2005
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	87	% [75-125]	6020	05/03/2005
Arsenic Dry Basis	88	% [75-125]	6010B	04/28/2005
Barium Dry Basis	120	% [75-125]	6010B	05/03/2005
Cadmium Dry Basis	92	% [75-125]	6010B	04/28/2005
Chromium Dry Basis	96	% [75-125]	6010B	04/28/2005
Copper Dry Basis	107	% [75-125]	6010B	05/03/2005
Iron Dry Basis	(2)	% [75-125]	6010B	05/02/2005
Lead Dry Basis	(2)	% [75-125]	6010B	04/28/2005
Manganese Dry Basis	(2)	% [75-125]	6010B	05/02/2005
Mercury Dry Basis	108	% [75-125]	6020A	05/02/2005
Nickel Dry Basis	99	% [75-125]	6010B	04/28/2005
Silver Dry Basis	107	% [75-125]	6010B	04/28/2005
Zinc Dry Basis	(2)	% [75-125]	6010B	05/02/2005
ICP/AA Batch#/Digest Date	1264	-----	3050B-M	04/27/2005
ICPMS Batch#/Digest Date	1268	-----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1268	-----	3050B-HG	04/28/2005

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Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-68	Description: MATRIX SPIKE DUPLICATE OF	Matrix: SOIL
Date Received: 04/22/2005	2005040193-47	
Date Collected: 04/19/2005	Collected by: JOE FAUBION	

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
ORGANICS				
Organic Carbon dry basis	24 (6)*	RPD [0-20]	24	04/29/2005
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	1	RPD [0-20]	6020	05/03/2005
Arsenic Dry Basis	4	RPD [0-20]	6010B	04/28/2005
Barium Dry Basis	3	RPD [0-20]	6010B	05/03/2005
Cadmium Dry Basis	0	RPD [0-20]	6010B	04/28/2005
Chromium Dry Basis	5	RPD [0-20]	6010B	04/28/2005
Copper Dry Basis	4	RPD [0-20]	6010B	05/03/2005
Iron Dry Basis	4	RPD [0-20]	6010B	05/02/2005
Lead Dry Basis	14	RPD [0-20]	6010B	04/28/2005
Manganese Dry Basis	8	RPD [0.20]	6010B	05/02/2005
Mercury Dry Basis	7	RPD [0-20]	6020A	05/02/2005
Nickel Dry Basis	2	RPD [0-20]	6010B	04/28/2005
Silver Dry Basis	4	RPD [0-20]	6010B	04/28/2005
Zinc Dry Basis	4	RPD [0-20]	6010B	05/02/2005
ICP/AA Batch#/Digest Date	1264	-----	3050B-M	04/27/2005
ICPMS Batch#/Digest Date	1268	-----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1268	-----	3050B-HG	04/28/2005

*Matrix Spike Duplicate of 2005040193-47

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Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-69 Description: SOIL LAB CONTROL SAMPLE Matrix: SOIL

Date Received: ----

Date Collected: ---- Collected by: PREPARED BY LAB

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
ORGANICS				
Organic Carbon dry basis	88	% [73-131]	24	04/29/2005
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	79	% [10-223]	6020	05/03/2005
Arsenic Dry Basis	103	% [79-121]	6010B	04/28/2005
Barium Dry Basis	89	% [80-120]	6010B	05/03/2005
Cadmium Dry Basis	102	% [80-120]	6010B	04/28/2005
Chromium Dry Basis	105	% [79-122]	6010B	04/28/2005
Copper Dry Basis	91	% [82-118]	6010B	05/03/2005
Iron Dry Basis	105	% [57-143]	6010B	05/02/2005
Lead Dry Basis	104	% [79-121]	6010B	04/28/2005
Manganese Dry Basis	101	% [80-120]	6010B	04/28/2005
Mercury Dry Basis	91	% [59-141]	6020A	05/02/2005
Nickel Dry Basis	103	% [82-118]	6010B	04/28/2005
Silver Dry Basis	104	% [61-138]	6010B	04/28/2005
Zinc Dry Basis	101	% [79-121]	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1264	----	3050B-M	04/27/2005
CPMS Batch#/Digest Date	1266	----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1268	----	3050B-HG	04/28/2005

Northern Analytical Laboratories, Inc.

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Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-70	Description: AQUEOUS LAB CONTROL	Matrix: WATER
Date Received: -----	SAMPLE	
Date Collected: -----	Collected by: PREPARED BY LAB	

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
ORGANICS				
Organic Carbon dry basis	NA	----	----	----
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	90	% [80-120]	6020	05/03/2005
Arsenic Dry Basis	101	% [80-120]	6010B	04/28/2005
Barium Dry Basis	94	% [80-120]	6010B	05/03/2005
Cadmium Dry Basis	100	% [80-120]	6010B	04/28/2005
Chromium Dry Basis	98	% [80-120]	6010B	04/28/2005
Copper Dry Basis	90	% [80-120]	6010B	05/03/2005
Iron Dry Basis	106	% [80-120]	6010B	05/02/2005
Lead Dry Basis	103	% [80-120]	6010B	04/28/2005
Manganese Dry Basis	103	% [80-120]	6010B	04/28/2005
Mercury Dry Basis	98	% [80-120]	6020A	05/02/2005
Nickel Dry Basis	102	% [80-120]	6010B	04/28/2005
Silver Dry Basis	99	% [80-120]	6010B	04/28/2005
Zinc Dry Basis	98	% [80-120]	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1264	----	3050B-M	04/27/2005
ICPMS Batch#/Digest Date	1268	----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1268	----	3050B-HG	04/28/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040193-71 Description: METHOD BLANK Matrix: WATER

Date Received: ----

Date Collected: ---- Collected by: PREPARED BY LAB

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
ORGANICS				
Organic Carbon dry basis	<0.1		24	04/29/2005
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<0.05	mg/l	6020	05/03/2005
Arsenic Dry Basis	<0.1	mg/l	6010B	04/28/2005
Barium Dry Basis	<0.05	mg/l	6010B	05/03/2005
Cadmium Dry Basis	<0.02	mg/l	6010B	04/28/2005
Chromium Dry Basis	<0.02	mg/l	6010B	04/28/2005
Copper Dry Basis	<0.1	mg/l	6010B	05/03/2005
Iron Dry Basis	<0.1	mg/l	6010B	05/02/2005
Lead Dry Basis	<0.1	mg/l	6010B	04/28/2005
Manganese Dry Basis	<0.02	mg/l	6010B	04/28/2005
Mercury Dry Basis	<0.005	mg/l	6020A	05/02/2005
Nickel Dry Basis	<0.05	mg/l	6010B	04/28/2005
Silver Dry Basis	<0.05	mg/l	6010B	04/28/2005
Zinc Dry Basis	<0.1	mg/l	6010B	04/28/2005
ICP/AA Batch#/Digest Date	1264	----	3050B-M	04/27/2005
ICPMS Batch#/Digest Date	1268	----	3050B-SB	04/28/2005
Mercury Batch #/Digest Date	1268	----	3050B-HG	04/28/2005

Spring Meadows Lake (SML)
Project or Site Name

51139-30SMLSRI
Project Number

Joe Fambion
Sampler Name (Printed)

Ed Surbrugg
Project Manager, Report to

CHAIN OF CUSTODY RECORD



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442-7182
Fax

DATE COLLECTED	TIME COLLECTED	SAMPLE LOCATION OR DESCRIPTION	COMP OR GRAB	SAMPLE MATRIX	NO. OF CONTAINERS	ANALYSIS REQUIRED				NOTES	LAB NUMBER
						TAL Metals	Particulates	CEC	pH		
4/18/05	0900	TP-151	G	Soil	1	X					2005
	0920	TP-152	G	Soil	1	X					04/0193
	0931	TP-153A			1	X					1
	0935	TP-153B			1	X					2
	0945	TP-154A			1	X					3
	0952	TP-154B			1	X					4
	1015	TP-155A			1	X					5
	1020	TP-155B			1	X					6
	1025	TP-156A			1	X					7
	1030	TP-156B			1	X	X	X		CEC = Cation Exchange Capacity	8
	1045	TP-157A			1	X	X	X		Partial Agricultural (pH, Ca, Mg, hard water, chloride sulfate)	9
	1050	TP-157B			1	X	X	X		Partial Agricultural (pH, Ca, Mg, hard water, chloride sulfate)	10
					1	X	X	X		Partial Agricultural (pH, Ca, Mg, hard water, chloride sulfate)	11
					1	X	X	X		Partial Agricultural (pH, Ca, Mg, hard water, chloride sulfate)	12

Relinquished by: [Signature] Date: 4-21-05 Time: 1610 Received by:

Relinquished by: [Signature] Date: 4/22/05 Time: 0930 Received by: [Signature]

Relinquished by: [Signature] Date: [] Time: [] Received by: [Signature]

CHAIN OF CUSTODY RECORD

Project for Site Name: 51129-30-SML5RI

Project Number: 51129-30-SML5RI

Project Manager, Report to: Joe Fabbion

Sampler Name (Printed): Ed Sorbrugg

Project Manager, Report to: Ed Sorbrugg

NORTHERN Analytical Laboratories, Inc.

602 South 25th Street
Billings, Montana 59101
Ph: 406-254-7226 • Fax: 406-254-1389
nlabs@wy.net

Report to (Firm or Agency): 7 West 6th Ave Ste 612

Address: Helena MT 59601

City: Helena State: MT Zip: 59601

Phone: 406-442-5588 Fax: 406-442-7182

DATE COLLECTED	TIME COLLECTED	SAMPLE LOCATION OR DESCRIPTION	COMP OR GRAB	SAMPLE MATRIX	NO. OF CONTAINERS	ANALYSIS REQUIRED	NOTES	LAB NUMBER
4/18/05	1100	TP-158A	G	Soil	1	CEC		2005
	1105	TP-158B			1	CEC		2416193
	1115	TP-159A			1	CEC		13
	1125	TP-160A			1	CEC		14
	1140	TP-161A			1	CEC		15
	1154	TP-163A			1	CEC		16
	1200	TP-163B			1	CEC		17
	1230	TP-163A			1	CEC		18
	1345	TP-164A			1	CEC		19
	1349	TP-164B			1	CEC		20
	1402	TP-165A			1	CEC		21
	1420	TP-166A			1	CEC		22
					1	CEC		23
					1	CEC		24

Relinquished by: Joe Fabbion

Date: 4-21-05 Time: 1610

Received by:

Relinquished by: Joe Fabbion

Date: 4/22/05 Time: 1610

Received by:

Relinquished by:

Date:

Received by:

Spring Meadow Lake (SML)

Project or Site Name

51129-30 SMLSR

Project Number

Joe Foubion

Sampler Name (Printed)

Ed Surbrugg

Project Manager, Report 16

CHAIN OF CUSTODY RECORD

NORTHERN

Analytical Laboratories, Inc.

602 South 25th Street

Billings, Montana 59101

Ph: 406-254-7226 • Fax: 406-254-1389

nlabs@wnl.net

Tetra Tech EM Inc.
Report to (Firm or Agency)
7102st 6th Ave, Suite 612
Address
Helena MT 59601
City State Zip
406 442-5582 / 406-442-7182
Phone Fax

DATE COLLECTED	TIME COLLECTED	SAMPLE LOCATION OR DESCRIPTION	COMP OR GRAB	SAMPLE MATRIX	NO. OF CONTAINERS	ANALYSIS REQUIRED				NOTES	LAB NUMBER
						TAL	CEC	PAHs	PCBs		
4/18/05	1425	TP-166B	G	Soil	1	X					2005 ✓
	1445	TP-167A			1	X					2005 ✓
	1450	TP-167B			1	X	X				2005 ✓
	1525	TP-168A			1	X	X	X			2005 ✓
	1530	TP-168B			1	X					2005 ✓
	1545	TP-168C			1	X					2005 ✓
	1555	TP-169A			1	X					2005 ✓
	1600	TP-169B			1	X	X	X			2005 ✓
4/19/05	947	TP-170A			1	X					2005 ✓
	950	TP-170B			1	X					2005 ✓
	951	TP-170C			1	X					2005 ✓
	1012	TP-171A			1	X					2005 ✓
Relinquished by: [Signature]						Received by:					
Relinquished by: [Signature]						Received by: [Signature]					
Relinquished by: [Signature]						Received by: [Signature]					

Report to (Firm or Agency)

51129-305MCSI

Project Number

Joe Foubion

Sampler Name (Printed)

Ed Surbrugg
Project Manager, Report to

Project Manager, Report to



Analytical Laboratories, Inc.

602 South 25th Street

Billings, Montana 59101

Ph: 406-254-7226 • Fax: 406-254-1389

nlab@wplab.net

DATE COLLECTED	TIME COLLECTED	SAMPLE LOCATION OR DESCRIPTION	COMP OR GRAB	SAMPLE MATRIX	NO OF CONTAINERS	ANALYSIS REQUIRED										NOTES	LAB NUMBER
						TAL	1	2	3	4	5	6	7	8	9		
4/19/05	1014	TP-171B	G	Sol	1	X										37	
	1017	TP-171C			1	X										38	
	1035	TP-172A			1	X										39	
	1100	TP-173A			1	X										40	
	1102	TP-173B			1	X										41	
	1104	TP-173C			1	X										42	
	1136	TP-174A			1	X										43	
	1140	TP-174B			1	X										44	
	1143	TP-174C			1	X										45	
	1144	TP-174D			1	X										46	
																47	

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Received by: *[Signature]*

Received by: *[Signature]*

Received by: *[Signature]*

Date: 4-21-05

Date: 4/22/05

Date: 4/22/05

Time: 1610

Time: 0933

Time: 1610

Wyoming Inland Lake (WIL)

Project or Site Name

511291-30-SMIL-001

Project Number

Joe Fawcett

Sampler Name (Printed)

Ed Surbrugg

Project Manager, Report to

CHAIN OF CUSTODY RECORD



Analytical Laboratories, Inc.

602 South 25th Street

Billings, Montana 59101

Ph: 406-254-7226 • Fax: 406-254-1389

nlab@wtp.net

Tetra Tech EMT

Report to (Firm or Agency)

7 West 6th Ave Suite 601

Address

Helena MT 59101

City State Zip

(406) 442-5588

Phone Fax

442-7153

DATE COLLECTED	TIME COLLECTED	SAMPLE LOCATION OR DESCRIPTION	COMP OR GRAB	SAMPLE MATRIX	NO. OF CONTAINERS	ANALYSIS REQUIRED				NOTES	LAB NUMBER
						TOTAL METALS	FIELD PREPARED	DISSOLVED METALS	OTHER		
4-21-05	10:45	SD-201	grab	Soil water	1	X	X	X		* TAL Metals = Sb, As, Ba, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Ni, Ag, Zn	47
	11:02	SD-202		Soil	1	X	X	X			48
	11:15	SD-203		Soil	1	X	X	X		* TOC = Total Organic Carbon	49
	11:25	SW-201		water	2		X	X		* Dissolved Metal samples need filtering and preservation at the lab.	
	11:35	SD-204		Soil	1	X	X	X			50
	11:40	SD-205		Soil	1	X	X	X			51
	11:45	SD-206		Soil	1					assign same status as before samples new 4/22/05	52
	12:00	SW-202		water	2		X	X			
	12:08	SD-207		Soil	1	X	X	X			53
	12:12	SD-208		Soil	1	X	X	X			54
	12:45	SW-203		Soil water	2	X	X	X			
	12:45	SW-203	grab	water	2		X	X			

Relinquished by:

Received by:

Date

4-21-05

Time

1610

Relinquished by:

Received by:

Date

4/22/05

Time

0930

Relinquished by:

Received by:

Date

4/22/05

Time

0930



SAMPLE RECEIPT CHECKLIST

Dear Valued Client: This checklist documents the condition of your sample(s) as it (they) arrived at our lab. Please review it and familiarize yourself with its contents. Should you have any questions or comments, please contact us. Thank you for your use of our services.

Client Name Tetra Tech Date Time Received 4/22/05 0930
Project Spring Meadows Received by NEW
Laboratory Number(s) 040192 & 193 Carrier Name Sed Ex
Checklist Completed by NEW 4/22/05 Sample Type Solid/H₂O
Initials Date

- | | YES | NO | | YES | NO |
|---|-------------------------------------|-------------------------------------|-----------------------------------|-------------------------------------|--------------------------|
| 1. Shipping container in good condition? | ☒ | ☐ | 14. pH check performed by: _____ | ☒ | ☐ |
| 2. Custody seals present on shipping container? | ☒ | ☐ | 15. Metals bottle(s) pH <2? | ☒ | ☐ |
| Condition: Intact ☒ Broken ☐ | | | 16. Nutrient bottle(s) pH <2? | ☒ | ☐ |
| 3. Chain of custody present? | ☒ | ☐ | 17. Cyanide bottle(s) pH >12? | ☒ | ☐ |
| 4. Chain of custody signed when relinquished and received? | ☒ | ☐ | 18. Sulfide bottle(s) pH >9? | ☒ | ☐ |
| 5. Chain of custody agrees with sample labels? | ☒ | ☐ | 19. TOC bottle(s) pH <2? | ☒ | ☐ |
| 6. Custody seals on sample bottles? | ☐ | ☒ | 20. Phenolics bottle(s) pH <2? | ☒ | ☐ |
| Condition: Intact ☐ Broken ☐ | | | 21. Oil & grease bottle(s) pH <2? | ☒ | ☐ |
| 7. Samples in proper container/bottle?* | ☒ | ☐ | (checked by analyst) | ☒ | ☐ |
| 8. Sample containers intact?* | ☒ | ☐ | 22. EPH/DRO bottle(s) pH <2? | ☒ | ☐ |
| 9. Sufficient sample volume for indicated test?* | ☒ | ☐ | (checked by analyst) | ☒ | ☐ |
| 10. Ice/Frozen Blue Ice present in shipping container? (circle one) | ☒ | ☒ | 23. Volatiles (VOA) pH <2? | ☒ | ☐ |
| container temperature 1. <u>14.6°C</u> 2. <u>2.0°C</u> 3. _____ | | | (checked by analyst) | ☒ | ☐ |
| (if <0 or >10) | | | 24. Semivolatiles (525) pH <2? | ☒ | ☐ |
| 11. All samples rec'd within holding time?* | ☒ | ☐ | (checked by analyst) | ☒ | ☐ |
| 12. VOA vials have zero headspace? | ☒ | ☐ | 25. Other test types | ☒ | ☐ |
| * (if contains >5mm headspace) | ☒ | ☐ | 26. Client contacted? | ☒ | ☐ |
| 13. Trip Blank received? | ☒ | ☐ | 27. Person contacted | ☒ | ☐ |
| | ☒ | ☐ | 28. Date contacted | ☒ | ☐ |

NOTES: Samples may be affected when not transported at the temperature recommended by the EPA for the test you've selected. Please contact the lab if you have concerns about the temperature of your samples.

* Critical item - if marked "NO" contact lab manager.

COMMENTS: _____

REPORT TO: ATTN: JOHN KOERTH
MONTANA DEPT. OF ENVIRONMENTAL QUALITY
P.O. BOX 200901
HELENA, MT 59620-0901

DATE: May 17, 2005
JOB NUMBER: 90-933-14
PAGE: 1 of 10
INVOICE NO.: 5040192

REPORT OF: Water Analysis – Spring Meadow Lake (SML) – S1129-30SMLSRI

CASE NARRATIVE:

On April 22, 2005 these water samples (laboratory numbers 2005040192-1 through -5) were received in our laboratory for analysis. Tests were conducted in accordance with EPA/600/4-79-020 "Methods for Chemical Analysis of Water and Wastes; "Standard Methods for the Examination of Water and Wastewater", 18th Edition; EPA/600/R-93-100 "Methods for the Determination of Inorganic Substances in Environmental Samples"; EPA/600/R-94-111 "Methods for the Determination of Metals in Environmental Samples", Supplement I.

The results of the analysis are shown on the following pages. A < sign indicates the value reported was the practical quantitation limit for this sample using the method described. Concentrations of analyte, if present, below this were not quantifiable. Sample results are not corrected for analyte blank concentrations. Values in brackets are the quality control limits for the associated quality control test.

The condition of the samples upon receipt at the laboratory is noted on the attached sample receipt checklist. Chain of custody documentation is enclosed.

Reviewed by Denise Jensen
Denise Jensen - Quality Assurance Coordinator

cc: Attn: Ed Surbrugg
Tetra Tech EMI
7 West 6th Ave., Suite 612
Helena, MT 59601

Attachments: Chain of Custody (2)
Sample Receipt Checklist

ba

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30-SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.:	2005040192-1	Description: SW-201	Matrix: WATER
Date Received:	04/22/2005		
Date Collected:	04/21/2005	Collected by: JOE FAUBION	

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
ANIONS				
Chloride as Cl	15	mg/l	325.3	04/25/2005
Sulfate as SO4	44	mg/l	375.2	05/02/2005
CATIONS				
Caicium as Ca	30	mg/l	200.7	04/25/2005
Hardness as CaCO3	128	mg/l	2340B	05/17/2005
Magnesium as Mg	13	mg/l	200.7	04/25/2005
INORGANICS				
Electrical Conductivity	360	umhos/cm	2510B	04/29/2005
pH	8.9	S.U.	150.1	04/22/2005
TARGET ANALYTE LIST (DISSOLVED)				
Antimony as Sb (Dissolved)	<0.003	mg/l	200.8	04/28/2005
Arsenic as As (Dissolved)	0.012	mg/l	200.8	04/28/2005
Barium as Ba (Dissolved)	0.030	mg/l	200.8	04/28/2005
Cadmium as Cd (Dissolved)	<0.0001	mg/l	200.8	04/28/2005
Chromium as Cr (Dissolved)	0.004	mg/l	200.8	05/09/2005
Copper as Cu (Dissolved)	0.002	mg/l	200.8	04/28/2005
Iron as Fe (Dissolved)	<0.01	mg/l	200.7	04/25/2005
Lead as Pb (Dissolved)	<0.003	mg/l	200.8	04/28/2005
Manganese as Mn (Dissolved)	<0.005	mg/l	200.8	04/28/2005
Mercury as Hg (Dissolved)	<0.0006	mg/l	200.8	04/29/2005
Nickel as Ni (Dissolved)	<0.02	mg/l	200.8	05/09/2005
Silver as Ag (Dissolved)	<0.003	mg/l	200.8	04/28/2005
Zinc as Zn (Dissolved)	<0.01	mg/l	200.7	04/25/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30-SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040192-2	Description: SW-202	Matrix: WATER
Date Received: 04/22/2005		
Date Collected: 04/21/2005	Collected by: JOE FAUBION	

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
ANIONS				
Chloride as Cl	15	mg/l	325.3	04/25/2005
Sulfate as SO4	44	mg/l	375.2	05/02/2005
CATIONS				
Calcium as Ca	40	mg/l	200.7	04/25/2005
Hardness as CaCO3	153	mg/l	2340B	05/17/2005
Magnesium as Mg	13	mg/l	200.7	04/25/2005
INORGANICS				
Electrical Conductivity	386	umhos/cm	2510B	04/29/2005
pH	8.4	S.U.	150.1	04/22/2005
TARGET ANALYTE LIST (DISSOLVED)				
Antimony as Sb (Dissolved)	<0.003	mg/l	200.8	04/28/2005
Arsenic as As (Dissolved)	0.011	mg/l	200.8	04/28/2005
Barium as Ba (Dissolved)	0.037	mg/l	200.8	04/28/2005
Cadmium as Cd (Dissolved)	<0.0001	mg/l	200.8	04/28/2005
Chromium as Cr (Dissolved)	0.005	mg/l	200.8	05/09/2005
Copper as Cu (Dissolved)	0.006	mg/l	200.8	04/28/2005
Iron as Fe (Dissolved)	<0.01	mg/l	200.7	04/25/2005
Lead as Pb (Dissolved)	<0.003	mg/l	200.8	04/28/2005
Manganese as Mn (Dissolved)	<0.005	mg/l	200.8	04/28/2005
Mercury as Hg (Dissolved)	<0.0006	mg/l	200.8	04/29/2005
Nickel as Ni (Dissolved)	<0.02	mg/l	200.8	05/09/2005
Silver as Ag (Dissolved)	<0.003	mg/l	200.8	04/28/2005
Zinc as Zn (Dissolved)	<0.01	mg/l	200.7	04/25/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30-SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040192-3	Description: SW-203	Matrix: WATER
Date Received: 04/22/2005		
Date Collected: 04/21/2005	Collected by: JOE FAUBION	

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
ANIONS				
Chloride as Cl	13	mg/l	325.3	04/25/2005
Sulfate as SO4	36	mg/l	375.2	05/02/2005
CATIONS				
Calcium as Ca	21	mg/l	200.7	04/25/2005
Hardness as CaCO3	102	mg/l	2340B	05/17/2005
Magnesium as Mg	12	mg/l	200.7	04/25/2005
INORGANICS				
Electrical Conductivity	278	umhos/cm	2510B	04/29/2005
pH	9.2	S.U.	150.1	04/22/2005
TARGET ANALYTE LIST (DISSOLVED)				
Antimony as Sb (Dissolved)	<0.003	mg/l	200.8	04/28/2005
Arsenic as As (Dissolved)	0.030	mg/l	200.8	04/28/2005
Barium as Ba (Dissolved)	0.012	mg/l	200.8	04/28/2005
Cadmium as Cd (Dissolved)	<0.0001	mg/l	200.8	04/28/2005
Chromium as Cr (Dissolved)	0.003	mg/l	200.8	05/09/2005
Copper as Cu (Dissolved)	0.003	mg/l	200.8	04/28/2005
Iron as Fe (Dissolved)	0.01	mg/l	200.7	04/25/2005
Lead as Pb (Dissolved)	<0.003	mg/l	200.8	04/28/2005
Manganese as Mn (Dissolved)	0.018	mg/l	200.8	04/28/2005
Mercury as Hg (Dissolved)	<0.0006	mg/l	200.8	04/29/2005
Nickel as Ni (Dissolved)	<0.02	mg/l	200.8	05/09/2005
Silver as Ag (Dissolved)	<0.003	mg/l	200.8	04/28/2005
Zinc as Zn (Dissolved)	<0.01	mg/l	200.7	04/25/2005

Northern Analytical Laboratories, Inc.

Page 5

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30-SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.:	2005040192-4	Description:	MW-02	Matrix:	WATER
Date Received:	04/22/2005				
Date Collected:	04/21/2005	Collected by:	JOE FAUBION		

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
ANIONS				
Chloride as Cl	25	mg/l	325.3	04/25/2005
Sulfate as SO4	70	mg/l	375.2	05/02/2005
CATIONS				
Calcium as Ca	59	mg/l	200.7	04/25/2005
Hardness as CaCO3	271	mg/l	2340B	05/17/2005
Magnesium as Mg	30	mg/l	200.7	04/25/2005
INORGANICS				
Electrical Conductivity	615	umhos/cm	2510B	04/29/2005
pH	7.5	S.U.	150.1	04/22/2005
TARGET ANALYTE LIST (DISSOLVED)				
Antimony as Sb (Dissolved)	<0.003	mg/l	200.8	04/28/2005
Arsenic as As (Dissolved)	0.010	mg/l	200.8	04/28/2005
Barium as Ba (Dissolved)	0.043	mg/l	200.8	04/28/2005
Cadmium as Cd (Dissolved)	0.0004	mg/l	200.8	04/28/2005
Chromium as Cr (Dissolved)	0.008	mg/l	200.8	05/09/2005
Copper as Cu (Dissolved)	0.002	mg/l	200.8	04/28/2005
Iron as Fe (Dissolved)	<0.01	mg/l	200.7	04/25/2005
Lead as Pb (Dissolved)	<0.003	mg/l	200.8	04/28/2005
Manganese as Mn (Dissolved)	0.007	mg/l	200.8	04/28/2005
Mercury as Hg (Dissolved)	<0.0006	mg/l	200.8	04/29/2005
Nickel as Ni (Dissolved)	<0.02	mg/l	200.8	05/09/2005
Silver as Ag (Dissolved)	<0.003	mg/l	200.8	04/28/2005
Zinc as Zn (Dissolved)	0.04	mg/l	200.7	04/25/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30-SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040192-5	Description: MW-01	Matrix: WATER
Date Received: 04/22/2005		
Date Collected: 04/21/2005	Collected by: JOE FAUBION	

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
ANIONS				
Chloride as Cl	23	mg/l	325.3	04/25/2005
Sulfate as SO4	84	mg/l	375.2	05/02/2005
CATIONS				
Calcium as Ca	59	mg/l	200.7	04/25/2005
Hardness as CaCO3	267	mg/l	2340B	05/17/2005
Magnesium as Mg	29	mg/l	200.7	04/25/2005
INORGANICS				
Electrical Conductivity	587	umhos/cm	2510B	04/29/2005
pH	7.6	S.U.	150.1	04/22/2005
TARGET ANALYTE LIST (DISSOLVED)				
Antimony as Sb (Dissolved)	<0.003	mg/l	200.8	04/28/2005
Arsenic as As (Dissolved)	0.029	mg/l	200.8	04/28/2005
Barium as Ba (Dissolved)	0.041	mg/l	200.8	04/28/2005
Cadmium as Cd (Dissolved)	0.0001	mg/l	200.8	04/28/2005
Chromium as Cr (Dissolved)	0.008	mg/l	200.8	05/09/2005
Copper as Cu (Dissolved)	0.005	mg/l	200.8	04/28/2005
Iron as Fe (Dissolved)	<0.01	mg/l	200.7	04/25/2005
Lead as Pb (Dissolved)	<0.003	mg/l	200.8	04/28/2005
Manganese as Mn (Dissolved)	0.39	mg/l	200.8	04/28/2005
Mercury as Hg (Dissolved)	<0.0006	mg/l	200.8	04/29/2005
Nickel as Ni (Dissolved)	<0.02	mg/l	200.8	05/09/2005
Silver as Ag (Dissolved)	<0.003	mg/l	200.8	04/28/2005
Zinc as Zn (Dissolved)	<0.01	mg/l	200.7	04/25/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30-SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040192-6

Description: MATRIX SPIKE OF
2005040192-1

Matrix: WATER

Date Received: 04/22/2005

Date Collected: 04/21/2005

Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
ANIONS				
Chloride as Cl	103	% [79-122]	325.3	04/25/2005
Sulfate as SO4	109	% [82-125]	375.2	05/02/2005
CATIONS				
Calcium as Ca	110	% [84-112]	200.7	04/25/2005
Hardness as CaCO3	NA	----	----	----
Magnesium as Mg	106	% [85-112]	200.7	04/25/2005
INORGANICS				
Electrical Conductivity	NA	----	----	----
pH	NA	----	----	----
TARGET ANALYTE LIST (DISSOLVED)				
Antimony as Sb (Dissolved)	98	% [82-117]	200.8	04/28/2005
Arsenic as As (Dissolved)	101	% [80-124]	200.8	04/28/2005
Barium as Ba (Dissolved)	99	% [78-121]	200.8	04/28/2005
Cadmium as Cd (Dissolved)	98	% [82-116]	200.8	04/28/2005
Chromium as Cr (Dissolved)	98	% [72-116]	200.8	05/09/2005
Copper as Cu (Dissolved)	109	% [70-117]	200.8	04/28/2005
Iron as Fe (Dissolved)	98	% [84-115]	200.7	04/25/2005
Lead as Pb (Dissolved)	105	% [82-114]	200.8	04/28/2005
Manganese as Mn (Dissolved)	101	% [70-129]	200.8	04/28/2005
Mercury as Hg (Dissolved)	96	% [70-117]	200.8	04/29/2005
Nickel as Ni (Dissolved)	104	% [76-118]	200.8	05/09/2005
Silver as Ag (Dissolved)	97	% [70-119]	200.8	04/28/2005
Zinc as Zn (Dissolved)	98	% [80-124]	200.7	04/25/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30-SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040192-7	Description: MATRIX SPIKE DUPLICATE OF	Matrix: WATER
Date Received: 04/22/2005	2005040192-1	
Date Collected: 04/21/2005	Collected by: JOE FAUBION	

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
ANIONS				
Chloride as Cl	0	RPD [0-20]	325.3	04/25/2005
Sulfate as SO4	3	RPD [0-20]	375.2	05/02/2005
CATIONS				
Calcium as Ca	2	RPD [0-20]	200.7	04/25/2005
Hardness as CaCO3	NA	----	----	----
Magnesium as Mg	1	RPD [0-20]	200.7	04/25/2005
INORGANICS				
Electrical Conductivity	NA	----	----	----
pH	NA	----	----	----
TARGET ANALYTE LIST (DISSOLVED)				
Antimony as Sb (Dissolved)	1	RPD [0-20]	200.8	04/28/2005
Arsenic as As (Dissolved)	1	RPD [0-20]	200.8	04/28/2005
Barium as Ba (Dissolved)	1	RPD [0-20]	200.8	04/28/2005
Cadmium as Cd (Dissolved)	1	RPD [0-20]	200.8	04/28/2005
Chromium as Cr (Dissolved)	0	RPD [0-20]	200.8	05/09/2005
Copper as Cu (Dissolved)	7	RPD [0-20]	200.8	04/28/2005
Iron as Fe (Dissolved)	2	RPD [0-20]	200.7	04/25/2005
Lead as Pb (Dissolved)	1	RPD [0-20]	200.8	04/28/2005
Manganese as Mn (Dissolved)	0	RPD [0-20]	200.8	04/28/2005
Mercury as Hg (Dissolved)	2	RPD [0-20]	200.8	04/29/2005
Nickel as Ni (Dissolved)	1	RPD [0-20]	200.8	05/09/2005
Silver as Ag (Dissolved)	1	RPD [0-20]	200.8	04/28/2005
Zinc as Zn (Dissolved)	2	RPD [0-20]	200.7	04/25/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30-SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040192-8 Description: METHOD BLANK Matrix: WATER
 Date Received: 04/22/2005
 Date Collected: ----- Collected by: PREPARED BY LAB

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
ANIONS				
Chloride as Cl	<1	mg/l	325.3	04/25/2005
Sulfate as SO ₄	<5	mg/l	375.2	05/02/2005
CATIONS				
Calcium as Ca	<1	mg/l	200.7	04/25/2005
Hardness as CaCO ₃	<7	mg/l	2340B	05/17/2005
Magnesium as Mg	<1	mg/l	200.7	04/25/2005
INORGANICS				
Electrical Conductivity	<10	umhos/cm	2510B	04/29/2005
pH	NA	----	----	----
TARGET ANALYTE LIST (DISSOLVED)				
Antimony as Sb (Dissolved)	<0.003	mg/l	200.8	04/28/2005
Arsenic as As (Dissolved)	<0.003	mg/l	200.8	04/28/2005
Barium as Ba (Dissolved)	<0.005	mg/l	200.8	04/28/2005
Cadmium as Cd (Dissolved)	<0.0001	mg/l	200.8	04/28/2005
Chromium as Cr (Dissolved)	<0.001	mg/l	200.8	05/09/2005
Copper as Cu (Dissolved)	<0.001	mg/l	200.8	04/28/2005
Iron as Fe (Dissolved)	<0.01	mg/l	200.7	04/25/2005
Lead as Pb (Dissolved)	<0.003	mg/l	200.8	04/28/2005
Manganese as Mn (Dissolved)	<0.005	mg/l	200.8	04/28/2005
Mercury as Hg (Dissolved)	<0.0006	mg/l	200.8	04/29/2005
Nickel as Ni (Dissolved)	<0.02	mg/l	200.8	05/09/2005
Silver as Ag (Dissolved)	<0.003	mg/l	200.8	04/28/2005
Zinc as Zn (Dissolved)	<0.01	mg/l	200.7	04/25/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30-SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040192-9	Description: LABORATORY CONTROL	Matrix: WATER
Date Received: 04/22/2005	SAMPLE	
Date Collected: -----	Collected by: PREPARED BY LAB	

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
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ANIONS

Chloride as Cl	105	% [90-115]	325.3	04/25/2005
Sulfate as SO4	103	% [94-113]	375.2	05/02/2005

CATIONS

Calcium as Ca	102	% [92-111]	200.7	04/25/2005
Hardness as CaCO3	NA	-----	-----	-----
Magnesium as Mg	99	% [92-115]	200.7	04/25/2005

INORGANICS

Electrical Conductivity	101	% [90-110]	2510B	04/29/2005
pH	100	% [99-101]	150.1	04/22/2005

TARGET ANALYTE LIST (DISSOLVED)

Antimony as Sb (Dissolved)	102	% [86-110]	200.8	04/28/2005
Arsenic as As (Dissolved)	98	% [85-111]	200.8	04/28/2005
Barium as Ba (Dissolved)	98	% [86-110]	200.8	04/28/2005
Cadmium as Cd (Dissolved)	100	% [88-110]	200.8	04/28/2005
Chromium as Cr (Dissolved)	102	% [85-115]	200.8	05/09/2005
Copper as Cu (Dissolved)	96	% [87-113]	200.8	04/28/2005
Iron as Fe (Dissolved)	102	% [92-111]	200.7	04/25/2005
Lead as Pb (Dissolved)	100	% [86-113]	200.8	04/28/2005
Manganese as Mn (Dissolved)	100	% [85-115]	200.8	04/28/2005
Mercury as Hg (Dissolved)	106	% [85-115]	200.8	04/29/2005
Nickel as Ni (Dissolved)	100	% [85-114]	200.8	05/09/2005
Silver as Ag (Dissolved)	101	% [85-114]	200.8	04/28/2005
Zinc as Zn (Dissolved)	101	% [89-115]	200.7	04/25/2005

Spring Meadow Lake (SML)

Project or Site Name

S11291-30-SML

Project Number

Joe Fawcett

Sampler Name (Printed)

Ed Surbrugg

Project Manager, Report to

CHAIN OF CUSTODY RECORD

NORTHERN

Analytical Laboratories, Inc.

602 South 25th Street

Billings, Montana 59101

Ph: 406-254-7226 • Fax: 406-254-1389

nlabs@wtp.net

Tetra Tech EMI

Report to (Firm or Agency)

7 West 6th Ave Suite 6012

Address

Helena MT 59601

City State Zip

(406) 442-5588

Phone

442-7183

DATE COLLECTED	TIME COLLECTED	SAMPLE LOCATION OR DESCRIPTION	COMP OR GRAB	SAMPLE MATRIX	NO. OF CONTAINERS	ANALYSIS REQUIRED				NOTES	LAB NUMBER
						TAL Metals	Field Parameters	Dissolved Metals	Specials		
4-21-05	10:45	SD-201	grab	Soil water	1	X	X			* TAL Metals = Sb, As, Ba, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Ni, Ag, Zn	2005 0416192
	11:02	SD-202		Soil	1	X	X				
	11:15	SD-203		Soil	1	X	X			* TOC = Total Organic Carbon	
	11:25	SW-201		water	2			X		* Dissolved Metal samples need filtering and preservation at the lab.	1
	11:35	SD-204		Soil	1	X	X				
	11:40	SD-205		Soil	1	X	X				
	11:45	SD-206		Soil	1						
	12:00	SW-202		water	2			X	X		2
	12:08	SD-207		Soil	1	X	X				
	12:12	SD-208		Soil	1	X	X				
	12:45	SW-203		Soil water	2	X	X	X			
	12:45	SW-203	grab	water	2			X	X		3
Relinquished by: J-F						Received by:					
Relinquished by: Sed Ex						Received by: P. M. Nelson					
Relinquished by:						Received by:					

[illegible]

CHAIN OF CUSTODY RECORD

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DATE COLLECTED	TIME COLLECTED	SAMPLE LOCATION OR DESCRIPTION	COMP OR GHAB	SAMPLE MATRIX	NO OF CONTAINERS	ANALYSIS REQUIRED				NOTES	LAB NUMBER	
						Field	Dissolved metals					
4-21-05	14:20	MW-02	grab	water	1	X				* Dissolved metal samples need filtering and preservation at the lab.	2005 0410	
	14:22	MW-02	↓	water	1		X				4	
	15:15	MW-01		water	1	X						5
	15:17	MW-01		water	1		X					6
										MS #1	7	
										MSD	8	
										MB	9	
										ACS		

SAMPLE RECEIPT CHECKLIST

Dear Valued Client: This checklist documents the condition of your sample(s) as it (they) arrived at our lab. Please review it and familiarize yourself with its contents. Should you have any questions or comments, please contact us. Thank you for your use of our services.

Client Name Tetra Tech Date/Time Received 4/22/05 0930
Project Spring Meadow Received by mw
Laboratory Number(s) 040192 & 193 Carrier Name Sed Ex
Checklist Completed by mw 4/22/05 Sample Type Sed/H₂O
Initials / Date

	YES	NO		YES	NO
1. Shipping container in good condition?	☒	☐	14. pH check performed by: _____	☒	☐
2. Custody seals present on shipping container?	☒	☐	15. Metals bottle(s) pH <2?	☒	☐
Condition: Intact ☒ Broken ☐			16. Nutrient bottle(s) pH <2?	☐	☐
3. Chain of custody present?	☒	☐	17. Cyanide bottle(s) pH >12?	☐	☐
4. Chain of custody signed when relinquished and received?	☒	☐	18. Sulfide bottle(s) pH >9?	☐	☐
5. Chain of custody agrees with sample labels?	☒	☐	19. TOC bottle(s) pH <2?	☐	☐
6. Custody seals on sample bottles?	☐	☒	20. Phenolics bottle(s) pH <2?	☐	☐
Condition: Intact ☐ Broken ☐			21. Oil & grease bottle(s) pH <2?	☐	☐
7. Samples in proper container/bottle?*	☒	☐	(checked by analyst)	☐	☐
8. Sample containers intact?*	☒	☐	22. EPH/DRO bottle(s) pH <2?	☐	☐
9. Sufficient sample volume for indicated test?*	☒	☐	(checked by analyst)	☐	☐
10. Ice/Frozen Blue Ice present in shipping container? (circle one)	☒	☒	23. Volatiles (VOA) pH <2?	☐	☐
container temperature 1. <u>14.6°C</u> 2. <u>2.0°C</u> 3. _____			(checked by analyst)	☐	☐
* (if <0 or >10)			24. Semivolatiles (525) pH <2?	☐	☐
11. All samples rec'd within holding time?*	☒	☐	(checked by analyst)	☐	☐
12. VOA vials have zero headspace?	☐	☒	25. Other test types	☐	☐
* (if contains >5mm headspace)			26. Client contacted?	☐	☐
13. Trip Blank received?	☐	☒	27. Person contacted	☐	☐
			28. Date contacted	☐	☐

NOTES: Samples may be affected when not transported at the temperature recommended by the EPA for the test you've selected. Please contact the lab if you have concerns about the temperature of your samples.

* Critical item - if marked "NO" contact lab manager.

COMMENTS: _____

REPORT TO: ATTN: JOHN KOERTH
MONTANA DEPT. OF ENVIRONMENTAL QUALITY
P.O. BOX 200901
HELENA, MT 59620-0901

DATE: June 9, 2005
JOB NUMBER: 90-933-14
PAGE: 1 of 7
INVOICE NO.: 5040193A

REPORT OF: Soil Analysis – Spring Meadow Lake (SML) – S1129-30SMLSRI

CASE NARRATIVE:

On April 22, 2005 these soil samples (laboratory numbers 2005040193-1 through -54) were received in our laboratory for analysis. The results of the original analyses requested on the chain of custody were reported on May 12, 2005. The client requested additional analyses for available potassium, phosphorous, and nitrogen on samples 2005040193-10, -12, -14, -19, -22, -27 and -32. The results of these analysis only are reported herein. Tests were conducted in accordance with American Society of Agronomy, "Methods of Soil Analysis", Western States Laboratory Proficiency Testing Program, "Soil & Plant Analytical Methods", and EPA/600/R-93-100 "Methods for the Determination of Inorganic Substances in Environmental Samples".

The results of the analysis are shown on the following pages. A < sign indicates the value reported was the practical quantitation limit for this sample using the method described. Concentrations of analyte, if present, below this were not quantifiable. Sample results are not corrected for analyte blank concentrations. Values in brackets are the quality control limits for the associated quality control test. RPD is the abbreviation for relative percent difference.

The condition of the samples upon receipt at the laboratory is noted on the attached sample receipt checklist. Chain of custody documentation is enclosed.

Reviewed by


Kathleen A. Smit - Laboratory Manager

Cc: Attn: Ed Surbrugg
Tetra Tech EMI
7 West 6th Ave.; Suite 612
Helena, MT 59601

Attachments: Chain of Custody (5)
Sample Receipt Checklist

nct

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Collected by: JOE FAUBION

Date Received: 04/22/2005

Matrix: SOIL

Order No.: 2005040193

Sample Number	Description	Date Collected	Measured Value	Test Units	Test Method	PQL Value	Date of Analysis
---------------	-------------	----------------	----------------	------------	-------------	-----------	------------------

Potassium Available dry basis

10	TP-156B	04/18/2005	510	mg/kg	S-5.10	10	05/25/2005
12	TP-157B	04/18/2005	130	mg/kg	S-5.10	10	05/25/2005
14	TP-158B	04/18/2005	50	mg/kg	S-5.10	10	05/25/2005
19	TP-162B	04/18/2005	260	mg/kg	S-5.10	10	05/25/2005
22	TP-164B	04/18/2005	260	mg/kg	S-5.10	10	05/25/2005
27	TP-167B	04/18/2005	60	mg/kg	S-5.10	10	05/25/2005
32	TP-169B	04/18/2005	100	mg/kg	S-5.10	10	05/25/2005
73	DUPLICATE	----	0	RPD [0-20]	S-5.10	10	05/25/2005
74	METHOD BLANK	----	<1	mg/l	S-5.10	1	05/25/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Collected by: PREPARED BY LAB

Date Received: 01/01/1900

Matrix: SOIL

Order No.: 2005040193

Sample Number	Description	Date Collected	Measured Value	Test Units	Test Method	PQL Value	Date of Analysis
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Potassium Available dry basis

75	AQUEOUS LAB CONTROL SAMPLE	----	100	% [80-120]	S-5.10	10	05/25/2005
76	SOIL LAB CONTROL SAMPLE	----	95	% [82-118]	S-5.10	10	05/25/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Collected by: JOE FAUBION

Date Received: 04/22/2005

Matrix: SOIL

Order No.: 2005040193

Sample Number	Description	Date Collected	Measured Value	Test Units	Test Method	PQL Value	Date of Analysis
Nitrate as N (KCL Extractable) Dry Basis							
10	TP-156B	04/18/2005	1.35	mg/kg	S3.10	0.3	05/21/2005
12	TP-157B	04/18/2005	1.78	mg/kg	S3.10	0.3	05/21/2005
14	TP-158B	04/18/2005	<1.5	mg/kg	S3.10	0.3	05/21/2005
19	TP-162B	04/18/2005	1.37	mg/kg	S3.10	0.3	05/21/2005
22	TP-164B	04/18/2005	1.02	mg/kg	S3.10	0.3	05/21/2005
27	TP-167B	04/18/2005	0.39	mg/kg	S3.10	0.3	05/21/2005
32	TP-169B	04/18/2005	0.53	mg/kg	S3.10	0.3	05/21/2005
73	DUPLICATE	—	4	RPD [0-20]	S3.10	0.3	05/21/2005
74	METHOD BLANK	----	<0.3	mg/kg	S3.10	0.3	05/21/2005

Northern Analytical Laboratories, Inc.

Page 5

Client Name: MT DEPT OF ENVIROMENTAL QUALITY
Project No.: S1129-30SMLSRI
Project Name: SPRING MEADOW LAKE
Collected by: PREPARED BY LAB
Date Received: 01/01/1900
Matrix: SOIL
Order No.: 2005040193

Sample Number	Description	Date Collected	Measured Value	Test Units	Test Method	PQL Value	Date of Analysis
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Nitrate as N (KCL Extractable) Dry Basis

75	AQUEOUS LAB CONTROL SAMPLE	----	96	% [90-110]	S3.10	0.3	05/21/2005
76	SOIL LAB CONTROL SAMPLE	----	92	% [80-120]	S3.10	0.3	05/21/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30SMLSRI

Project Name: SPRING MEADOW LAKE

Collected by: JOE FAUBION

Date Received: 04/22/2005

Matrix: SOIL

Order No.: 2005040193

Sample Number	Description	Date Collected	Measured Value	Test Units	Test Method	PQL Value	Date of Analysis
Phosphorous Available Dry Basis							
10	TP-156B	04/18/2005	151	mg/kg	S-4.10	4	05/26/2005
12	TP-157B	04/18/2005	<4	mg/kg	S-4.10	4	05/26/2005
14	TP-158B	04/18/2005	<4	mg/kg	S-4.10	4	05/26/2005
19	TP-162B	04/18/2005	9	mg/kg	S-4.10	4	05/26/2005
22	TP-164B	04/18/2005	34	mg/kg	S-4.10	4	05/26/2005
27	TP-167B	04/18/2005	4.8	mg/kg	S-4.10	4	06/03/2005
32	TP-169B	04/18/2005	34	mg/kg	S-4.10	4	05/26/2005
73	DUPLICATE	----	5	RPD [0-20]	S-4.10	4	05/26/2005
74	METHOD BLANK	----	<4	mg/kg	S-4.10	4	05/26/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY
Project No.: S1129-30SMLSRI
Project Name: SPRING MEADOW LAKE
Collected by: PREPARED BY LAB
Date Received: 01/01/1900
Matrix: SOIL
Order No.: 2005040193

Sample Number	Description	Date Collected	Measured Value	Test Units	Test Method	PQL Value	Date of Analysis
Phosphorous Available Dry Basis							
75	AQUEOUS LAB CONTROL SAMPLE	----	NA	----	----	4	----
76	SOIL LAB CONTROL SAMPLE	----	111	% [68-132]	S-4.10	4	05/26/2005

Spring Meadow Lake (SML)
Project or Site Name

51129-305MLSRI
Project Number

Joe Foubion
Sampler Name (Printed)

Ed Surbrugg
Project Manager, Report to

CHAIN OF CUSTODY RECORD

NORTHERN

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Terra Tech Env Inc

Report to (Firm or Agency)

56 7 West 6th Ave
Suite 612
Helena MT 59601
City State Zip

406 442-5588
Phone

442-7182
Fax

DATE COLLECTED	TIME COLLECTED	SAMPLE LOCATION OR DESCRIPTION	COMP OR GRAB	SAMPLE MATRIX	NO. OF CONTAINERS	ANALYSIS REQUIRED				NOTES	LAB NUMBER
						TAL Metals	Particulates	CEC	Particulates		
4/18/05	0900	TP-151	G	Soil	1	X					2005
	0930	TP-152	G	Soil	1	X					040193
	0931	TP-153A			1	X					
	0935	TP-153B			1	X					
	0945	TP-154A			1	X					
	0952	TP-154B			1	X					
	1015	TP-155A			1	X					
	1020	TP-155B			1	X					
	1025	TP-156A			1	X					
	1030	TP-156B			1	X					
	1045	TP-157A			1	X					
	1050	TP-157B			1	X					
Relinquished by: [Signature]						Received by:		TAL Metals			
Relinquished by: [Signature]						Received by:		Sb, As, Ba, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Ni, Ag, Zn			
Relinquished by: [Signature]						Received by:					

CEC = Cation Exchange Capacity
Partial Agricultural
pH: 6.5 - 7.5
chloride sulfate
H₂O

Spring Meadows Lake (SML)
Project or Site Name

S1129-30-SMLSRI
Project Number

Joe Fabbion
Project Manager

Ed Sorbrugg
Sampler Name (Printed)

Report to

CHAIN OF CUSTODY RECORD



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Billings, Montana 59101
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7 West 6th Ave Ste 612
Address

Helena MT 59601
City State Zip

406-442-5588 / 406-442-7182
Phone Fax

DATE COLLECTED	TIME COLLECTED	SAMPLE LOCATION OR DESCRIPTION	COMP OR GRAB	SAMPLE MATRIX	NO. OF CONTAINERS	ANALYSIS REQUIRED										NOTES	LAB NUMBER
						THL Met	CEC	Perchlorate	Ag	Li	Si	Al	Fe	Mn	Pb		
4/18/05	1100	TP-158A	G	Soil	1	X											2005
	1105	TP-158B			1	X	X										040193
	1115	TP-159A			1	X											13
	1125	TP-160A			1	X	X										14
	1140	TP-161A			1	X											15
	1154	TP-162A			1	X											16
	1200	TP-162B			1	X											17
	1230	TP-163A			1	X	X										18
	1345	TP-164A			1	X											19
	1349	TP-164B			1	X	X										20
	1402	TP-165A			1	X	X										21
	1420	TP-166A			1	X											22
																	23
																	24

Relinquished by:

Joe Fabbion

Date

4-21-05

Time

1610

Received by:

Relinquished by:

Seaton

Date

4/22/05

Time

0930

Received by:

M. W. W. W. W.

Relinquished by:

Date

Time

Received by:

51129-305M15RT
Project Number

Joe Fambion

Sampler Name (Printed)

Ed Surbrugg
Project Manager, Report 16

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NORTHERN

Analytical Laboratories, Inc.

Helong MT 59601 109365

City / State / Zip

Phone 406-442-5588 / 406-442-7182 Fax

DATE COLLECTED	TIME COLLECTED	SAMPLE LOCATION OR DESCRIPTION	COMP OR GRAB	SAMPLE MATRIX	NO. OF CONTAINERS	ANALYSIS REQUIRED				NOTES	LAB NUMBER
						TAL Meth	CFC	Pvth/ISO	Pvth/1A		
4/18/05	1425	TP-166B	G	Soil	1	X					2005 04/0193
	1445	TP-167A			1	X					25
	1450	TP-167B			1	X	X	X			26
	1525	TP-168A			1	X					27
	1530	TP-168B			1	X					28
	1545	TP-168C			1	X					29
	1555	TP-169A			1	X					30
	1600	TP-169B			1	X	X	X			31
4/19/05	947	TP-170A			1	X					32
	950	TP-170B			1	X					33
	951	TP-170C			1	X					34
	1012	TP-171A			1	X					35
											36

Relinquished by: *[Signature]*

Relinquished by: *[Signature]*

Relinquished by: *[Signature]*

Received by: _____

Received by: _____

Received by: _____

Date: 4-21-05

Date: 4/22/05

Date: _____

Time: 1610

Time: 0930

Time: _____

CHAIN OF CUSTODY RECORD

NORTHERN

Analytical Laboratories, Inc.

602 South 25th Street
Billings, Montana 59101
Ph: 406-254-7226 • Fax: 406-254-1389
nlabs@wtp.net

Project or Site Name
S1129-30-SD-201-203

Project Number

Joe Fausion

Sampler Name (Printed)

Ed Surbrugg

Project Manager, Report to

Report to (Firm or Agency)

7 West 6th Ave Suite 612

Address

Helena MT 59101

City State Zip

(406) 442-5588

Phone Fax 442-7182

DATE COLLECTED	TIME COLLECTED	SAMPLE LOCATION OR DESCRIPTION	COMP OR GRAB	SAMPLE MATRIX	NO. OF CONTAINERS	ANALYSIS REQUIRED				NOTES	LAB NUMBER
						TOTAL METALS	FIELD PARAMETERS	DISSOLVED METALS	RESIDUALS		
4-21-05	10:45	SD-201	grab	Soil water	1	X	X	X	X	*TAL Metals = Sb, As, Ba, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Ni, Ag, Zn	2005 040193
	11:02	SD-202		Soil	1	X	X				47
	11:15	SD-203		Soil	1	X	X			*TOC = Total Organic Carbon	48
	11:25	SW-201		water	2		X	X		*Dissolved Metal samples need filtering and preservation at the lab.	49
	11:35	SD-204		Soil	1	X	X				50
	11:40	SD-205		Soil	1	X	X				51
	11:45	SD-206		Soil	1					acquire same test as before samples new 4/22/05	52
	12:00	SW-202		water	2		X	X			
	12:08	SD-207		Soil	1	X	X				53
	12:12	SD-208		Soil	1	X	X				54
	12:45	SW-203		Soil water	2	X	X				
	12:45	SW-203	grab	water	2		X	X			
Relinquished by:	Date	Time	Received by:								
J-4	4-21-05	1610	Received by:								
Ed Ex	4/22/05	09:20	Received by:								
Relinquished by:	Date	Time	Received by:								

SAMPLE RECEIPT CHECKLIST

Dear Valued Client: This checklist documents the condition of your sample(s) as it (they) arrived at our lab. Please review it and familiarize yourself with its contents. Should you have any questions or comments, please contact us. Thank you for your use of our services.

Client Name Tetra Tech Date/Time Received 4/22/05 0930
 Project Spring Meadow Received by mw
 Laboratory Number(s) 040192 & 193 Carrier Name Seal Ex
 Checklist Completed by mw 4/22/05 Sample Type Soil/H₂O
Initials / Date

- | | YES | NO | | YES | NO |
|---|-------------------------------------|-------------------------------------|-----------------------------------|-------------------------------------|-------------------------------------|
| 1. Shipping container in good condition? | ☒ | ☐ | 14. pH check performed by: _____ | ☒ | ☐ |
| 2. Custody seals present on shipping container? | ☒ | ☐ | 15. Metals bottle(s) pH <2? | ☒ | ☐ |
| Condition: Intact ☒ Broken ☐ | | | 16. Nutrient bottle(s) pH <2? | ☐ | ☒ |
| 3. Chain of custody present? | ☒ | ☐ | 17. Cyanide bottle(s) pH >12? | ☐ | ☐ |
| 4. Chain of custody signed when relinquished and received? | ☒ | ☐ | 18. Sulfide bottle(s) pH >9? | ☐ | ☐ |
| 5. Chain of custody agrees with sample labels? | ☒ | ☐ | 19. TOC bottle(s) pH <2? | ☐ | ☐ |
| 6. Custody seals on sample bottles? | ☐ | ☒ | 20. Phenolics bottle(s) pH <2? | ☐ | ☐ |
| Condition: Intact ☐ Broken ☐ | | | 21. Oil & grease bottle(s) pH <2? | ☐ | ☐ |
| 7. Samples in proper container/bottle?* | ☒ | ☐ | (checked by analyst) | ☐ | ☐ |
| 8. Sample containers intact?* | ☒ | ☐ | 22. EPH/DRO bottle(s) pH <2? | ☐ | ☐ |
| 9. Sufficient sample volume for indicated test?* | ☒ | ☐ | (checked by analyst) | ☐ | ☐ |
| 10. Ice/Frozen Blue Ice present in shipping container? (circle one) | ☒ | ☒ | 23. Volatiles (VOA) pH <2? | ☐ | ☐ |
| container temperature 1. <u>14.6°C</u> 2. <u>2.0°C</u> 3. _____ | | | (checked by analyst) | ☐ | ☐ |
| * (if <0 or >10) | | | 24. Semivolatiles (525) pH <2? | ☐ | ☐ |
| 11. All samples rec'd within holding time?* | ☒ | ☐ | (checked by analyst) | ☐ | ☐ |
| 12. VOA vials have zero headspace? | ☐ | ☒ | 25. Other test types | ☐ | ☐ |
| * (if contains >5mm headspace) | | | 26. Client contacted? | ☐ | ☐ |
| 13. Trip Blank received? | ☐ | ☒ | 27. Person contacted | ☐ | ☐ |
| | | | 28. Date contacted | ☐ | ☐ |

NOTES: Samples may be affected when not transported at the temperature recommended by the EPA for the test you've selected. Please contact the lab if you have concerns about the temperature of your samples.

* Critical item - if marked "NO" contact lab manager.

COMMENTS: _____

NORTHERN

Analytical Laboratories, Inc.

602 South 25th Street
P O Box 30315
Billings, MT 59101
Telephone: (406) 254-7226
Fax: (406) 254-1389

REPORT TO: ATTN: JOHN KOERTH
MONTANA DEPT. OF ENVIRONMENTAL QUALITY
P.O. BOX 200901
HELENA, MT 59620-0901

Revised: June 14, 2005
DATE: May 17, 2005
JOB NUMBER: 90-933-14
PAGE: 1 of 19
INVOICE NO.: 5040192A

REPORT OF: Water Analysis – Spring Meadow Lake (SML) – S1129-30SMLSRI

CASE NARRATIVE:

On April 22, 2005 these water samples (laboratory numbers 2005040192-1 through -5) were received in our laboratory for analysis. Tests were conducted in accordance with EPA/600/4-79-020 "Methods for Chemical Analysis of Water and Wastes; "Standard Methods for the Examination of Water and Wastewater", 18th Edition; EPA/600/R-93-100 "Methods for the Determination of Inorganic Substances in Environmental Samples"; EPA/600/R-94-111 "Methods for the Determination of Metals in Environmental Samples", Supplement I.

The results of the analysis are shown on the following pages. A < sign indicates the value reported was the practical quantitation limit for this sample using the method described. Concentrations of analyte, if present, below this were not quantifiable. Sample results are not corrected for analyte blank concentrations. Values in brackets are the quality control limits for the associated quality control test.

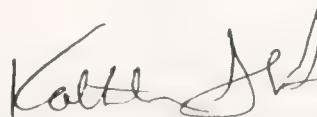
The condition of the samples upon receipt at the laboratory is noted on the attached sample receipt checklist. Chain of custody documentation is enclosed.

The following footnote was used in our report:

(1) Verified by a second analysis.

Revision: The client requested additional analysis of samples 2005040192-1 through -5 for total recoverable metals. The results of this analysis are reported herein. The dissolved chromium concentrations have been revised to reflect another analysis performed on June 7, 2005. The footnote (1) was added to the report.

Reviewed by



Kathleen A. Smit - Laboratory Manager

Cc: Attn: Ed Surbrugg
Tetra Tech EMI
7 West 6th Ave.: Suite 612
Helena, MT 59601

Attachments: Chain of Custody (2)
Sample Receipt Checklist

nct

Northern Analytical Laboratories, Inc.

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Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30-SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040192-1	Description: SW-201	Matrix: WATER
Date Received: 04/22/2005		
Date Collected: 04/21/2005	Collected by: JOE FAUBION	

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
-----------------	----------------	------------	-------------	------------------

ANIONS

Chloride as Cl	15	mg/l	325.3	04/25/2005
Sulfate as SO4	44	mg/l	375.2	05/02/2005

CATIONS

Calcium as Ca	30	mg/l	200.7	04/25/2005
Hardness as CaCO3	128	mg/l	2340B	05/17/2005
Magnesium as Mg	13	mg/l	200.7	04/25/2005

INORGANICS

Electrical Conductivity	360	umhos/cm	2510B	04/29/2005
pH	8.9	S.U.	150.1	04/22/2005

METALS

Antimony as Sb (Total Recoverable)	<0.003	mg/l	200.8	05/31/2005
Arsenic as As (Total Recoverable)	0.012	mg/l	200.8	05/31/2005
Barium as Ba (Total Recoverable)	0.029	mg/l	200.8	05/31/2005
Cadmium as Cd (Total Recoverable)	<0.0001	mg/l	200.8	05/31/2005
Chromium as Cr (Total Recoverable)	<0.001	mg/l	200.8	05/31/2005
Copper as Cu (Total Recoverable)	<0.001(1)	mg/l	200.8	05/31/2005
Iron as Fe (Total Recoverable)	0.02	mg/l	200.7	05/27/2005
Lead as Pb (Total Recoverable)	<0.003	mg/l	200.8	05/31/2005
Manganese as Mn (Total Recoverable)	<0.005	mg/l	200.8	05/31/2005
Mercury as Hg (Total Recoverable)	<0.0006	mg/l	200.8	05/19/2005
Nickel as Ni (Total Recoverable)	<0.02	mg/l	200.8	05/31/2005
Silver as Ag (Total Recoverable)	<0.003	mg/l	200.8	05/31/2005
Zinc as Zn (Total Recoverable)	<0.01	mg/l	200.7	05/27/2005
ICPMS Batch#/Digest Date	1339	----	200.8 TR	05/26/2005
Mercury Batch #/Digest Date	1326	----	200.7 TR	05/19/2005

TARGET ANALYTE LIST (DISSOLVED)

Antimony as Sb (Dissolved)	<0.003	mg/l	200.8	04/28/2005
Arsenic as As (Dissolved)	0.012	mg/l	200.8	04/28/2005
Barium as Ba (Dissolved)	0.030	mg/l	200.8	04/28/2005
Cadmium as Cd (Dissolved)	<0.0001	mg/l	200.8	04/28/2005
Chromium as Cr (Dissolved)	<0.001	mg/l	200.8	06/07/2005
Copper as Cu (Dissolved)	0.002(1)	mg/l	200.8	04/28/2005
Iron as Fe (Dissolved)	<0.01	mg/l	200.7	04/25/2005
Lead as Pb (Dissolved)	<0.003	mg/l	200.8	04/28/2005

Northern Analytical Laboratories, Inc.

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Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30-SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040192-1

Description: SW-201

Matrix: WATER

Date Received: 04/22/2005

Date Collected: 04/21/2005

Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
Manganese as Mn (Dissolved)	<0.005	mg/l	200.8	04/28/2005
Mercury as Hg (Dissolved)	<0.0006	mg/l	200.8	04/29/2005
Nickel as Ni (Dissolved)	<0.02	mg/l	200.8	05/09/2005
Silver as Ag (Dissolved)	<0.003	mg/l	200.8	04/28/2005
Zinc as Zn (Dissolved)	<0.01	mg/l	200.7	04/25/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30-SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040192-2 Description: SW-202 Matrix: WATER
 Date Received: 04/22/2005
 Date Collected: 04/21/2005 Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
ANIONS				
Chloride as Cl	15	mg/l	325.3	04/25/2005
Sulfate as SO ₄	44	mg/l	375.2	05/02/2005
CATIONS				
Calcium as Ca	40	mg/l	200.7	04/25/2005
Hardness as CaCO ₃	153	mg/l	2340B	05/17/2005
Magnesium as Mg	13	mg/l	200.7	04/25/2005
INORGANICS				
Electrical Conductivity	386	umhos/cm	2510B	04/29/2005
pH	8.4	S.U.	150.1	04/22/2005
METALS				
Antimony as Sb (Total Recoverable)	<0.003	mg/l	200.8	05/31/2005
Arsenic as As (Total Recoverable)	0.012	mg/l	200.8	05/31/2005
Barium as Ba (Total Recoverable)	0.037	mg/l	200.8	05/31/2005
Cadmium as Cd (Total Recoverable)	<0.0001	mg/l	200.8	05/31/2005
Chromium as Cr (Total Recoverable)	<0.001	mg/l	200.8	05/31/2005
Copper as Cu (Total Recoverable)	<0.001(1)	mg/l	200.8	05/31/2005
Iron as Fe (Total Recoverable)	0.02	mg/l	200.7	05/27/2005
Lead as Pb (Total Recoverable)	<0.003	mg/l	200.8	05/31/2005
Manganese as Mn (Total Recoverable)	0.011	mg/l	200.8	05/31/2005
Mercury as Hg (Total Recoverable)	<0.0006	mg/l	200.8	05/19/2005
Nickel as Ni (Total Recoverable)	<0.02	mg/l	200.8	05/31/2005
Silver as Ag (Total Recoverable)	<0.003	mg/l	200.8	05/31/2005
Zinc as Zn (Total Recoverable)	<0.01	mg/l	200.7	05/27/2005
ICPMS Batch#/Digest Date	1339	----	200.8 TR	05/26/2005
Mercury Batch #/Digest Date	1326	----	200.7 TR	05/19/2005
TARGET ANALYTE LIST (DISSOLVED)				
Antimony as Sb (Dissolved)	<0.003	mg/l	200.8	04/28/2005
Arsenic as As (Dissolved)	0.011	mg/l	200.8	04/28/2005
Barium as Ba (Dissolved)	0.037	mg/l	200.8	04/28/2005
Cadmium as Cd (Dissolved)	<0.0001	mg/l	200.8	04/28/2005
Chromium as Cr (Dissolved)	<0.001	mg/l	200.8	06/07/2005
Copper as Cu (Dissolved)	0.006(1)	mg/l	200.8	04/28/2005
Iron as Fe (Dissolved)	<0.01	mg/l	200.7	04/25/2005
Lead as Pb (Dissolved)	<0.003	mg/l	200.8	04/28/2005

Northern Analytical Laboratories, Inc.

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Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30-SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040192-2	Description: SW-202	Matrix: WATER
Date Received: 04/22/2005		
Date Collected: 04/21/2005	Collected by: JOE FAUBION	

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
Manganese as Mn (Dissolved)	<0.005	mg/l	200.8	04/28/2005
Mercury as Hg (Dissolved)	<0.0006	mg/l	200.8	04/29/2005
Nickel as Ni (Dissolved)	<0.02	mg/l	200.8	05/09/2005
Silver as Ag (Dissolved)	<0.003	mg/l	200.8	04/28/2005
Zinc as Zn (Dissolved)	<0.01	mg/l	200.7	04/25/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30-SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.:	2005040192-3	Description:	SW-203	Matrix:	WATER
Date Received:	04/22/2005				
Date Collected:	04/21/2005	Collected by:	JOE FAUBION		

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
ANIONS				
Chloride as Cl	13	mg/l	325.3	04/25/2005
Sulfate as SO4	36	mg/l	375.2	05/02/2005
CATIONS				
Calcium as Ca	21	mg/l	200.7	04/25/2005
Hardness as CaCO3	102	mg/l	2340B	05/17/2005
Magnesium as Mg	12	mg/l	200.7	04/25/2005
INORGANICS				
Electrical Conductivity	278	umhos/cm	2510B	04/29/2005
pH	9.2	S.U.	150.1	04/22/2005
METALS				
Antimony as Sb (Total Recoverable)	<0.003	mg/l	200.8	05/31/2005
Arsenic as As (Total Recoverable)	0.032	mg/l	200.8	05/31/2005
Barium as Ba (Total Recoverable)	0.009	mg/l	200.8	05/31/2005
Cadmium as Cd (Total Recoverable)	<0.0001	mg/l	200.8	05/31/2005
Chromium as Cr (Total Recoverable)	<0.001	mg/l	200.8	05/31/2005
Copper as Cu (Total Recoverable)	0.001(1)	mg/l	200.8	05/31/2005
Iron as Fe (Total Recoverable)	0.06	mg/l	200.7	05/27/2005
Lead as Pb (Total Recoverable)	<0.003	mg/l	200.8	05/31/2005
Manganese as Mn (Total Recoverable)	0.051	mg/l	200.8	05/31/2005
Mercury as Hg (Total Recoverable)	<0.0006	mg/l	200.8	05/19/2005
Nickel as Ni (Total Recoverable)	<0.02	mg/l	200.8	05/31/2005
Silver as Ag (Total Recoverable)	<0.003	mg/l	200.8	05/31/2005
Zinc as Zn (Total Recoverable)	<0.01	mg/l	200.7	05/27/2005
ICPMS Batch#/Digest Date	1339	----	200.8 TR	05/26/2005
Mercury Batch #/Digest Date	1326	----	200.7 TR	05/19/2005
TARGET ANALYTE LIST (DISSOLVED)				
Antimony as Sb (Dissolved)	<0.003	mg/l	200.8	04/28/2005
Arsenic as As (Dissolved)	0.030	mg/l	200.8	04/28/2005
Barium as Ba (Dissolved)	0.012	mg/l	200.8	04/28/2005
Cadmium as Cd (Dissolved)	<0.0001	mg/l	200.8	04/28/2005
Chromium as Cr (Dissolved)	<0.001	mg/l	200.8	06/07/2005
Copper as Cu (Dissolved)	0.003(1)	mg/l	200.8	04/28/2005
Iron as Fe (Dissolved)	0.01	mg/l	200.7	04/25/2005
Lead as Pb (Dissolved)	<0.003	mg/l	200.8	04/28/2005

Northern Analytical Laboratories, Inc.

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Client Name: MT DEPT OF ENVIROMENTAL QUALITY**Project No.:** S1129-30-SMLSRI**Project Name:** SPRING MEADOW LAKE**Sample No.:** 2005040192-3**Description:** SW-203**Matrix:** WATER**Date Received:** 04/22/2005**Date Collected:** 04/21/2005**Collected by:** JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
Manganese as Mn (Dissolved)	0.018	mg/l	200.8	04/28/2005
Mercury as Hg (Dissolved)	<0.0006	mg/l	200.8	04/29/2005
Nickel as Ni (Dissolved)	<0.02	mg/l	200.8	05/09/2005
Silver as Ag (Dissolved)	<0.003	mg/l	200.8	04/28/2005
Zinc as Zn (Dissolved)	<0.01	mg/l	200.7	04/25/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30-SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040192-4	Description: MW-02	Matrix: WATER
Date Received: 04/22/2005		
Date Collected: 04/21/2005	Collected by: JOE FAUBION	

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
ANIONS				
Chloride as Cl	25	mg/l	325.3	04/25/2005
Sulfate as SO4	70	mg/l	375.2	05/02/2005
CATIONS				
Calcium as Ca	59	mg/l	200.7	04/25/2005
Hardness as CaCO3	271	mg/l	2340B	05/17/2005
Magnesium as Mg	30	mg/l	200.7	04/25/2005
INORGANICS				
Electrical Conductivity	615	umhos/cm	2510B	04/29/2005
pH	7.5	S.U.	150.1	04/22/2005
METALS				
Antimony as Sb (Total Recoverable)	<0.003	mg/l	200.8	05/31/2005
Arsenic as As (Total Recoverable)	0.012	mg/l	200.8	05/31/2005
Barium as Ba (Total Recoverable)	0.045	mg/l	200.8	05/31/2005
Cadmium as Cd (Total Recoverable)	0.0005	mg/l	200.8	05/31/2005
Chromium as Cr (Total Recoverable)	<0.001	mg/l	200.8	05/31/2005
Copper as Cu (Total Recoverable)	0.002(1)	mg/l	200.8	05/31/2005
Iron as Fe (Total Recoverable)	0.68	mg/l	200.7	05/27/2005
Lead as Pb (Total Recoverable)	0.005	mg/l	200.8	05/31/2005
Manganese as Mn (Total Recoverable)	0.026	mg/l	200.8	05/31/2005
Mercury as Hg (Total Recoverable)	<0.0006	mg/l	200.8	05/19/2005
Nickel as Ni (Total Recoverable)	<0.02	mg/l	200.8	05/31/2005
Silver as Ag (Total Recoverable)	<0.003	mg/l	200.8	05/31/2005
Zinc as Zn (Total Recoverable)	0.07	mg/l	200.7	05/27/2005
ICPMS Batch#/Digest Date	1339	----	200.8 TR	05/26/2005
Mercury Batch #/Digest Date	1326	----	200.7 TR	05/19/2005
TARGET ANALYTE LIST (DISSOLVED)				
Antimony as Sb (Dissolved)	<0.003	mg/l	200.8	04/28/2005
Arsenic as As (Dissolved)	0.010	mg/l	200.8	04/28/2005
Barium as Ba (Dissolved)	0.043	mg/l	200.8	04/28/2005
Cadmium as Cd (Dissolved)	0.0004	mg/l	200.8	04/28/2005
Chromium as Cr (Dissolved)	<0.001	mg/l	200.8	06/07/2005
Copper as Cu (Dissolved)	0.002(1)	mg/l	200.8	04/28/2005
Iron as Fe (Dissolved)	<0.01	mg/l	200.7	04/25/2005
Lead as Pb (Dissolved)	<0.003	mg/l	200.8	04/28/2005

Northern Analytical Laboratories, Inc.

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Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30-SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040192-4

Description: MW-02

Matrix: WATER

Date Received: 04/22/2005

Date Collected: 04/21/2005

Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
Manganese as Mn (Dissolved)	0.007	mg/l	200.8	04/28/2005
Mercury as Hg (Dissolved)	<0.0006	mg/l	200.8	04/29/2005
Nickel as Ni (Dissolved)	<0.02	mg/l	200.8	05/09/2005
Silver as Ag (Dissolved)	<0.003	mg/l	200.8	04/28/2005
Zinc as Zn (Dissolved)	0.04	mg/l	200.7	04/25/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30-SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040192-5	Description: MW-01	Matrix: WATER
Date Received: 04/22/2005		
Date Collected: 04/21/2005	Collected by: JOE FAUBION	

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
ANIONS				
Chloride as Cl	23	mg/l	325.3	04/25/2005
Sulfate as SO4	84	mg/l	375.2	05/02/2005
CATIONS				
Calcium as Ca	59	mg/l	200.7	04/25/2005
Hardness as CaCO3	267	mg/l	2340B	05/17/2005
Magnesium as Mg	29	mg/l	200.7	04/25/2005
INORGANICS				
Electrical Conductivity	587	umhos/cm	2510B	04/29/2005
pH	7.6	S.U.	150.1	04/22/2005
METALS				
Antimony as Sb (Total Recoverable)	<0.003	mg/l	200.8	05/31/2005
Arsenic as As (Total Recoverable)	0.057	mg/l	200.8	05/31/2005
Barium as Ba (Total Recoverable)	0.13	mg/l	200.8	05/31/2005
Cadmium as Cd (Total Recoverable)	0.0005	mg/l	200.8	05/31/2005
Chromium as Cr (Total Recoverable)	0.017	mg/l	200.8	06/01/2005
Copper as Cu (Total Recoverable)	0.025(1)	mg/l	200.8	06/01/2005
Iron as Fe (Total Recoverable)	13.7	mg/l	200.7	05/27/2005
Lead as Pb (Total Recoverable)	0.039	mg/l	200.8	05/31/2005
Manganese as Mn (Total Recoverable)	0.88	mg/l	200.8	06/01/2005
Mercury as Hg (Total Recoverable)	<0.0006	mg/l	200.8	05/19/2005
Nickel as Ni (Total Recoverable)	<0.02	mg/l	200.8	06/01/2005
Silver as Ag (Total Recoverable)	<0.003	mg/l	200.8	05/31/2005
Zinc as Zn (Total Recoverable)	0.08	mg/l	200.7	05/27/2005
ICPMS Batch#/Digest Date	1339	----	200.8 TR	05/26/2005
Mercury Batch #/Digest Date	1326	----	200.7 TR	05/19/2005
TARGET ANALYTE LIST (DISSOLVED)				
Antimony as Sb (Dissolved)	<0.003	mg/l	200.8	04/28/2005
Arsenic as As (Dissolved)	0.029	mg/l	200.8	04/28/2005
Barium as Ba (Dissolved)	0.041	mg/l	200.8	04/28/2005
Cadmium as Cd (Dissolved)	0.0001	mg/l	200.8	04/28/2005
Chromium as Cr (Dissolved)	<0.001	mg/l	200.8	06/07/2005
Copper as Cu (Dissolved)	0.005(1)	mg/l	200.8	04/28/2005
Iron as Fe (Dissolved)	<0.01	mg/l	200.7	04/25/2005
Lead as Pb (Dissolved)	<0.003	mg/l	200.8	04/28/2005

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Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30-SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040192-5 Description: MW-01 Matrix: WATER
Date Received: 04/22/2005
Date Collected: 04/21/2005 Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
Manganese as Mn (Dissolved)	0.39	mg/l	200.8	04/28/2005
Mercury as Hg (Dissolved)	<0.0006	mg/l	200.8	04/29/2005
Nickel as Ni (Dissolved)	<0.02	mg/l	200.8	05/09/2005
Silver as Ag (Dissolved)	<0.003	mg/l	200.8	04/28/2005
Zinc as Zn (Dissolved)	<0.01	mg/l	200.7	04/25/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30-SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040192-6 Description: MATRIX SPIKE OF Matrix: WATER
 Date Received: 04/22/2005 2005040192-1
 Date Collected: 04/21/2005 Collected by: JOE FAUBION

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
ANIONS				
Chloride as Cl	103	% [79-122]	325.3	04/25/2005
Sulfate as SO4	109	% [82-125]	375.2	05/02/2005
CATIONS				
Calcium as Ca	110	% [84-112]	200.7	04/25/2005
Hardness as CaCO3	NA	----	----	----
Magnesium as Mg	106	% [85-112]	200.7	04/25/2005
INORGANICS				
Electrical Conductivity	NA	----	----	----
pH	NA	----	----	----
METALS				
Antimony as Sb (Total Recoverable)	97	% [92-128]	200.8	05/31/2005
Arsenic as As (Total Recoverable)	103	% [74-124]	200.8	05/31/2005
Barium as Ba (Total Recoverable)	101	% [71-128]	200.8	05/31/2005
Cadmium as Cd (Total Recoverable)	102	% [81-114]	200.8	05/31/2005
Chromium as Cr (Total Recoverable)	92	% [73-117]	200.8	05/31/2005
Copper as Cu (Total Recoverable)	87	% [70-118]	200.8	05/31/2005
Iron as Fe (Total Recoverable)	112	% [73-130]	200.7	05/27/2005
Lead as Pb (Total Recoverable)	103	% [75-122]	200.8	05/31/2005
Manganese as Mn (Total Recoverable)	97	% [72-127]	200.8	05/31/2005
Mercury as Hg (Total Recoverable)	105	% [70-130]	200.8	05/19/2005
Nickel as Ni (Total Recoverable)	94	% [70-124]	200.8	05/31/2005
Silver as Ag (Total Recoverable)	82	% [70-130]	200.8	05/31/2005
Zinc as Zn (Total Recoverable)	112	% [73-129]	200.7	05/27/2005
ICPMS Batch#/Digest Date	1339	----	200.8 TR	05/26/2005
Mercury Batch #/Digest Date	1326	----	200.7 TR	05/19/2005
TARGET ANALYTE LIST (DISSOLVED)				
Antimony as Sb (Dissolved)	98	% [82-117]	200.8	04/28/2005
Arsenic as As (Dissolved)	101	% [80-124]	200.8	04/28/2005
Barium as Ba (Dissolved)	99	% [78-121]	200.8	04/28/2005
Cadmium as Cd (Dissolved)	98	% [82-116]	200.8	04/28/2005
Chromium as Cr (Dissolved)	103	% [72-116]	200.8	06/07/2005
Copper as Cu (Dissolved)	109	% [70-117]	200.8	04/28/2005
Iron as Fe (Dissolved)	98	% [84-115]	200.7	04/25/2005
Lead as Pb (Dissolved)	105	% [82-114]	200.8	04/28/2005

Northern Analytical Laboratories, Inc.

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Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30-SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040192-6	Description: MATRIX SPIKE OF	Matrix: WATER
Date Received: 04/22/2005	2005040192-1	
Date Collected: 04/21/2005	Collected by: JOE FAUBION	

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
Manganese as Mn (Dissolved)	101	% [70-129]	200.8	04/28/2005
Mercury as Hg (Dissolved)	96	% [70-117]	200.8	04/29/2005
Nickel as Ni (Dissolved)	104	% [76-118]	200.8	05/09/2005
Silver as Ag (Dissolved)	97	% [70-119]	200.8	04/28/2005
Zinc as Zn (Dissolved)	98	% [80-124]	200.7	04/25/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30-SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040192-7	Description: MATRIX SPIKE DUPLICATE OF	Matrix: WATER
Date Received: 04/22/2005	2005040192-1	
Date Collected: 04/21/2005	Collected by: JOE FAUBION	

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
ANIONS				
Chloride as Cl	0	RPD [0-20]	325.3	04/25/2005
Sulfate as SO4	3	RPD [0-20]	375.2	05/02/2005
CATIONS				
Calcium as Ca	2	RPD [0-20]	200.7	04/25/2005
Hardness as CaCO3	NA	----	----	----
Magnesium as Mg	1	RPD [0-20]	200.7	04/25/2005
INORGANICS				
Electrical Conductivity	NA	----	----	----
pH	NA	----	----	----
METALS				
Antimony as Sb (Total Recoverable)	1	RPD [0-20]	200.8	05/31/2005
Arsenic as As (Total Recoverable)	0	RPD [0-20]	200.8	05/31/2005
Barium as Ba (Total Recoverable)	0	RPD [0-20]	200.8	05/31/2005
Cadmium as Cd (Total Recoverable)	1	RPD [0-20]	200.8	05/31/2005
Chromium as Cr (Total Recoverable)	0	RPD [0-20]	200.8	05/31/2005
Copper as Cu (Total Recoverable)	1	RPD [0-20]	200.8	05/31/2005
Iron as Fe (Total Recoverable)	2	RPD [0-20]	200.7	05/27/2005
Lead as Pb (Total Recoverable)	1	RPD [0-20]	200.8	05/31/2005
Manganese as Mn (Total Recoverable)	1	RPD [0-20]	200.8	05/31/2005
Mercury as Hg (Total Recoverable)	2	RPD [0-20]	200.8	05/19/2005
Nickel as Ni (Total Recoverable)	2	RPD [0-20]	200.8	05/31/2005
Silver as Ag (Total Recoverable)	13	RPD [0-20]	200.8	05/31/2005
Zinc as Zn (Total Recoverable)	2	RPD [0-20]	200.7	05/27/2005
ICPMS Batch#/Digest Date	1339	----	200.8 TR	05/26/2005
Mercury Batch #/Digest Date	1326	----	200.7 TR	05/19/2005
TARGET ANALYTE LIST (DISSOLVED)				
Antimony as Sb (Dissolved)	1	RPD [0-20]	200.8	04/28/2005
Arsenic as As (Dissolved)	1	RPD [0-20]	200.8	04/28/2005
Barium as Ba (Dissolved)	1	RPD [0-20]	200.8	04/28/2005
Cadmium as Cd (Dissolved)	1	RPD [0-20]	200.8	04/28/2005
Chromium as Cr (Dissolved)	1	RPD [0-20]	200.8	06/07/2005
Copper as Cu (Dissolved)	7	RPD [0-20]	200.8	04/28/2005
Iron as Fe (Dissolved)	2	RPD [0-20]	200.7	04/25/2005
Lead as Pb (Dissolved)	1	RPD [0-20]	200.8	04/28/2005

Northern Analytical Laboratories, Inc.

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Client Name: MT DEPT OF ENVIROMENTAL QUALITY**Project No.:** S1129-30-SMLSRI**Project Name:** SPRING MEADOW LAKE

Sample No.: 2005040192-7	Description: MATRIX SPIKE DUPLICATE OF	Matrix: WATER
Date Received: 04/22/2005	2005040192-1	
Date Collected: 04/21/2005	Collected by: JOE FAUBION	

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
Manganese as Mn (Dissolved)	0	RPD [0-20]	200.8	04/28/2005
Mercury as Hg (Dissolved)	2	RPD [0-20]	200.8	04/29/2005
Nickel as Ni (Dissolved)	1	RPD [0-20]	200.8	05/09/2005
Silver as Ag (Dissolved)	1	RPD [0-20]	200.8	04/28/2005
Zinc as Zn (Dissolved)	2	RPD [0-20]	200.7	04/25/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30-SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040192-8	Description: METHOD BLANK	Matrix: WATER
Date Received: 04/22/2005		
Date Collected: —	Collected by: PREPARED BY LAB	

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
ANIONS				
Chloride as Cl	<1	mg/l	325.3	04/25/2005
Sulfate as SO4	<5	mg/l	375.2	05/02/2005
CATIONS				
Calcium as Ca	<1	mg/l	200.7	04/25/2005
Hardness as CaCO3	<7	mg/l	2340B	05/17/2005
Magnesium as Mg	<1	mg/l	200.7	04/25/2005
INORGANICS				
Electrical Conductivity	<10	umhos/cm	2510B	04/29/2005
pH	NA	----	----	----
METALS				
Antimony as Sb (Total Recoverable)	<0.003	mg/l	200.8	05/31/2005
Arsenic as As (Total Recoverable)	<0.003	mg/l	200.8	05/31/2005
Barium as Ba (Total Recoverable)	<0.005	mg/l	200.8	05/31/2005
Cadmium as Cd (Total Recoverable)	<0.0001	mg/l	200.8	05/31/2005
Chromium as Cr (Total Recoverable)	<0.001	mg/l	200.8	05/31/2005
Copper as Cu (Total Recoverable)	<0.001	mg/l	200.8	05/31/2005
Iron as Fe (Total Recoverable)	<0.01	mg/l	200.7	05/27/2005
Lead as Pb (Total Recoverable)	<0.003	mg/l	200.8	05/31/2005
Manganese as Mn (Total Recoverable)	<0.005	mg/l	200.8	05/31/2005
Mercury as Hg (Total Recoverable)	<0.0006	mg/l	200.8	05/19/2005
Nickel as Ni (Total Recoverable)	<0.02	mg/l	200.8	05/31/2005
Silver as Ag (Total Recoverable)	<0.003	mg/l	200.8	05/31/2005
Zinc as Zn (Total Recoverable)	<0.01	mg/l	200.7	05/27/2005
ICPMS Batch#/Digest Date	1339	----	200.8 TR	05/26/2005
Mercury Batch #/Digest Date	1326	----	200.7 TR	05/19/2005
TARGET ANALYTE LIST (DISSOLVED)				
Antimony as Sb (Dissolved)	<0.003	mg/l	200.8	04/28/2005
Arsenic as As (Dissolved)	<0.003	mg/l	200.8	04/28/2005
Barium as Ba (Dissolved)	<0.005	mg/l	200.8	04/28/2005
Cadmium as Cd (Dissolved)	<0.0001	mg/l	200.8	04/28/2005
Chromium as Cr (Dissolved)	<0.001	mg/l	200.8	06/07/2005
Copper as Cu (Dissolved)	<0.001	mg/l	200.8	04/28/2005
Iron as Fe (Dissolved)	<0.01	mg/l	200.7	04/25/2005
Lead as Pb (Dissolved)	<0.003	mg/l	200.8	04/28/2005

Northern Analytical Laboratories, Inc.

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Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30-SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040192-8

Description: METHOD BLANK

Matrix: WATER

Date Received: 04/22/2005

Date Collected: -----

Collected by: PREPARED BY LAB

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
Manganese as Mn (Dissolved)	<0.005	mg/l	200.8	04/28/2005
Mercury as Hg (Dissolved)	<0.0006	mg/l	200.8	04/29/2005
Nickel as Ni (Dissolved)	<0.02	mg/l	200.8	05/09/2005
Silver as Ag (Dissolved)	<0.003	mg/l	200.8	04/28/2005
Zinc as Zn (Dissolved)	<0.01	mg/l	200.7	04/25/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30-SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040192-9	Description: LABORATORY CONTROL	Matrix: WATER
Date Received: 04/22/2005	SAMPLE	
Date Collected: ----	Collected by: PREPARED BY LAB	

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
ANIONS				
Chloride as Cl	105	% [90-115]	325.3	04/25/2005
Sulfate as SO4	103	% [94-113]	375.2	05/02/2005
CATIONS				
Calcium as Ca	102	% [92-111]	200.7	04/25/2005
Hardness as CaCO3	NA	----	----	----
Magnesium as Mg	99	% [92-115]	200.7	04/25/2005
INORGANICS				
Electrical Conductivity	101	% [90-110]	2510B	04/29/2005
pH	100	% [99-101]	150.1	04/22/2005
METALS				
Antimony as Sb (Total Recoverable)	96	% [85-115]	200.8	05/31/2005
Arsenic as As (Total Recoverable)	92	% [85-115]	200.8	05/31/2005
Barium as Ba (Total Recoverable)	101	% [85-115]	200.8	05/31/2005
Cadmium as Cd (Total Recoverable)	101	% [85-113]	200.8	05/31/2005
Chromium as Cr (Total Recoverable)	99	% [85-115]	200.8	05/31/2005
Copper as Cu (Total Recoverable)	98	% [85-115]	200.8	05/31/2005
Iron as Fe (Total Recoverable)	108	% [91-115]	200.7	05/27/2005
Lead as Pb (Total Recoverable)	104	% [85-115]	200.8	05/31/2005
Manganese as Mn (Total Recoverable)	103	% [85-115]	200.8	05/31/2005
Mercury as Hg (Total Recoverable)	104	% [85-115]	200.8	05/19/2005
Nickel as Ni (Total Recoverable)	98	% [85-115]	200.8	05/31/2005
Silver as Ag (Total Recoverable)	100	% [85-115]	200.8	05/31/2005
Zinc as Zn (Total Recoverable)	107	% [85-115]	200.7	05/27/2005
ICPMS Batch#/Digest Date	1339	----	200.8 TR	05/26/2005
Mercury Batch #/Digest Date	1326	----	200.7 TR	05/19/2005
TARGET ANALYTE LIST (DISSOLVED)				
Antimony as Sb (Dissolved)	102	% [86-110]	200.8	04/28/2005
Arsenic as As (Dissolved)	98	% [85-111]	200.8	04/28/2005
Barium as Ba (Dissolved)	98	% [86-110]	200.8	04/28/2005
Cadmium as Cd (Dissolved)	100	% [88-110]	200.8	04/28/2005
Chromium as Cr (Dissolved)	106	% [85-115]	200.8	06/07/2005
Copper as Cu (Dissolved)	96	% [87-113]	200.8	04/28/2005
Iron as Fe (Dissolved)	102	% [92-111]	200.7	04/25/2005
Lead as Pb (Dissolved)	100	% [86-113]	200.8	04/28/2005

Northern Analytical Laboratories, Inc.

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Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: S1129-30-SMLSRI

Project Name: SPRING MEADOW LAKE

Sample No.: 2005040192-9 Description: LABORATORY CONTROL Matrix: WATER
Date Received: 04/22/2005 SAMPLE
Date Collected: ---- Collected by: PREPARED BY LAB

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
Manganese as Mn (Dissolved)	100	% [85-115]	200.8	04/28/2005
Mercury as Hg (Dissolved)	106	% [85-115]	200.8	04/29/2005
Nickel as Ni (Dissolved)	100	% [85-114]	200.8	05/09/2005
Silver as Ag (Dissolved)	101	% [85-114]	200.8	04/28/2005
Zinc as Zn (Dissolved)	101	% [89-115]	200.7	04/25/2005

Spring Meadow Lake (SML)

Object or Site Name

51129-30-SML

Object Number

Soc Faulstich

Amplifier Name (Printed)

Ed Surbrugg

Project Manager, Report to

CHAIN OF CUSTODY RECORD

NORTHERN

Analytical Laboratories, Inc.

602 South 25th Street
Billings, Montana 59101
Ph: 406-254-7226 • Fax: 406-254-1389
niabs@wtp.net

Extra Tech EMI
Report to (Firm or Agency)

7 West 6th Ave Suite 612

Address

Helena MT 59601

City State Zip

(406) 442-5588

Phone

442-7182 Fax

DATE COLLECTED	TIME COLLECTED	SAMPLE LOCATION OR DESCRIPTION	COMP OR GRAB	SAMPLE MATRIX	NO OF CONTAINERS	ANALYSIS REQUIRED				NOTES	LAB NUMBER
						TAL Metals	Field Parameters	Dissolved Metals	Residuals		
4-21-05	10:45	SD-201	grab	Soil	1	X				* TAL Metals = Sb, As, Ba, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Ni, Ag, Zn	2005
	11:02	SD-202		Soil	1	X					0410192
	11:15	SD-203		Soil	1	X					
	11:25	SW-201		water	2			X		* TOC = Total Organic Carbon	
	11:35	SD-204		Soil	1	X		X		* Dissolved Metal samples need filtering and preservation at the lab.	
	11:40	SD-205		Soil	1	X					
	11:45	SD-206		Soil	1						
	12:00	SW-202		water	2			X			2
	12:08	SD-207		Soil	1	X		X			
	12:12	SD-208		Soil	1	X		X			
	12:45	SW-203		Soil	1	X		X			
	12:45	SW-203	grab	water	2			X			3

Relinquished by: [Signature]
Relinquished by: [Signature]
Relinquished by: [Signature]

Received by: [Signature]
Received by: [Signature]
Received by: [Signature]

Spring meadow lake (SML)

Object or Site Name

51129-30-51LSPI

Object Number

The Fashion

amplifier Name (Printed)

Ed Surbrugg

Project Manager, Report to

CHAIN OF CUSTODY RECORD



Analytical Laboratories, Inc.

602 South 25th Street

Billings, Montana 59101

Ph: 406-254-7226 • Fax: 406-254-1389

n@labs@wtp.net

Tetra Tech EMI

Report to (Firm or Agency)

7 West 6th Ave Suite 602

Address

Helena HT 59601

City _____ State _____ Zip _____

(406) 1-442-5588 (406) 1-442-7182

Phone _____ Fax _____

DATE COLLECTED	TIME COLLECTED	SAMPLE LOCATION OR DESCRIPTION	COMP OR GRAB	SAMPLE MATRIX	NO OF CONTAINERS	ANALYSIS REQUIRED					NOTES	LAB NUMBER
						Field Parameters	Dissolved metals					
4-21-05	14:20	MW-02	grab	water	1	X					* Dissolved metal samples need filtering and preservation at the lab.	0410
	14:22	MW-02		water	1		X					
	15:15	MW-01		water	1	X						
	15:17	MW-01		water	1		X					
											MS #1	4
											MSD	7
											MB	8
											LCS	9

Relinquished by: [Signature]

Relinquished by: [Signature]

Relinquished by: [Signature]

Received by: _____

Received by: [Signature]

Received by: _____



SAMPLE RECEIPT CHECKLIST

Dear Valued Client: This checklist documents the condition of your sample(s) as it (they) arrived at our lab. Please review it and familiarize yourself with its contents. Should you have any questions or comments, please contact us. Thank you for your use of our services.

Client Name Tetra Tech Date/Time Received 4/22/05 0930
Project Spring Meadows Received by mw
Laboratory Number(s) 040192 & 193 Carrier Name Sed Ex
Checklist Completed by mw 4/22/05 Sample Type Soil/H₂O
Initials / Date

- | | YES | NO | | YES | NO |
|---|-------------------------------------|-------------------------------------|--|-------------------------------------|--------------------------|
| 1. Shipping container in good condition? | ☒ | ☐ | 14. pH check performed by: _____ | ☒ | ☐ |
| 2. Custody seals present on shipping container? | ☒ | ☐ | 15. Metals bottle(s) pH <2? | ☒ | ☐ |
| Condition: Intact ☒ Broken ☐ | | | 16. Nutrient bottle(s) pH <2? | ☒ | ☐ |
| 3. Chain of custody present? | ☒ | ☐ | 17. Cyanide bottle(s) pH >12? | ☒ | ☐ |
| 4. Chain of custody signed when relinquished and received? | ☒ | ☐ | 18. Sulfide bottle(s) pH >9? | ☒ | ☐ |
| 5. Chain of custody agrees with sample labels? | ☒ | ☐ | 19. TOC bottle(s) pH <2? | ☒ | ☐ |
| 6. Custody seals on sample bottles? | ☐ | ☒ | 20. Phenolics bottle(s) pH <2? | ☒ | ☐ |
| Condition: Intact ☐ Broken ☐ | | | 21. Oil & grease bottle(s) pH <2? (checked by analyst) | ☒ | ☐ |
| 7. Samples in proper container/bottle?* | ☒ | ☐ | 22. EPH/DRO bottle(s) pH <2? (checked by analyst) | ☒ | ☐ |
| 8. Sample containers intact?* | ☒ | ☐ | 23. Volatiles (VOA) pH <2? (checked by analyst) | ☒ | ☐ |
| 9. Sufficient sample volume for indicated test?* | ☒ | ☐ | 24. Semivolatiles (525) pH <2? (checked by analyst) | ☒ | ☐ |
| 10. Ice/Frozen Blue Ice present in shipping container? (circle one) | ☒ | ☒ | 25. Other test types | ☒ | ☐ |
| container temperature 1. <u>14.6°C</u> 2. <u>2.0°C</u> 3. _____ | | | 26. Client contacted? | ☒ | ☐ |
| * (if <0 or >10) | | | 27. Person contacted | ☒ | ☐ |
| 11. All samples rec'd within holding time?* | ☒ | ☐ | 28. Date contacted | ☒ | ☐ |
| 12. VOA vials have zero headspace? (if contains >5mm headspace) | ☒ | ☐ | | | |
| 13. Trip Blank received? | ☒ | ☐ | | | |

NOTES: Samples may be affected when not transported at the temperature recommended by the EPA for the test you've selected. Please contact the lab if you have concerns about the temperature of your samples.

* Critical item - if marked "NO" contact lab manager.

COMMENTS: _____

NORTHERN
Analytical Laboratories, Inc.**RECEIVED**

AUG 26 2005

Dept. of Environmental Quality
Remediation Division602 South 25th Street
P. O. Box 30315
Billings, Montana 59107
(406)254-7226
FAX (406)254-1389FAX TRANSMITTAL

PLEASE DELIVER TO:

John Koehn

COMPANY:

MDEG

FAX NUMBER:

406-841-9050

FROM:

Denise Tenger

DATE

8-26-05

OF PAGES

4

(including this page)

If there are any problems receiving this fax, contact:
Norma at (406) 254-7226

MESSAGE:

Following are the results of the sediment analysis
for the Spring Meadow samples. A final report will
be mailed on Mon.

CONFIDENTIALITY NOTICE

The documents accompanying this facsimile transmission contain confidential information which is legally privileged. The information is intended only for the use of the recipient named above. If you have received this facsimile in error, please notify us immediately at (406) 254-7226 to arrange for the return of the telecopied documents to us and you are hereby notified that any disclosure, copying, distribution, or the taking of any action in reliance on the contents of this information is strictly prohibited.

SENT BY: _____

DATE & TIME _____

Northern Analytical Laboratories, Inc.

Page 2

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: NONE GIVEN

Project Name: SPRING MEADOW BUGS & SEDIMENT

Sample No.: 2005070142-4

Description: SML 301 SD

Matrix: SEDIMENT

Date Received: 07/13/2005

Date Collected: 06/24/2005

Collected by: JOHN KOERTH

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
METALS				
Antimony Dry Basis	<5	mg/kg	6020	08/26/2005
Arsenic Dry Basis	15	mg/kg	6010B	08/24/2005
Barium Dry Basis	36	mg/kg	6010B	08/24/2005
Cadmium Dry Basis	<2	mg/kg	6010B	08/24/2005
Chromium Dry Basis	6	mg/kg	6010B	08/24/2005
Copper Dry Basis	13	mg/kg	6010B	08/24/2005
Iron Dry Basis	7800	mg/kg	6010B	08/24/2005
Lead Dry Basis	27	mg/kg	6010B	08/24/2005
Manganese Dry Basis	122	mg/kg	6010B	08/24/2005
Zinc Dry Basis	46	mg/kg	6010B	08/24/2005
Thallium Dry Basis	<10	mg/kg	6010B	08/24/2005
ICP/AA Batch#/Digest Date	1558	---	3050B-M	08/24/2005
ICPMS Batch#/Digest Date	1559	---	3050B-SB	08/24/2005

Northern Analytical Laboratories, Inc.

Page 3

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: NONE GIVEN

Project Name: SPRING MEADOW BUGS & SEDIMENT

Sample No.: 2005070142-5

Description: SML 302 SD

Matrix: SEDIMENT

Date Received: 07/13/2005

Date Collected: 06/24/2005

Collected by: JOHN KOERTH

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
METALS				
Antimony Dry Basis	<5	mg/kg	6020	08/26/2005
Arsenic Dry Basis	50	mg/kg	6010B	08/24/2005
Barium Dry Basis	55	mg/kg	6010B	08/24/2005
Cadmium Dry Basis	<2	mg/kg	6010B	08/24/2005
Chromium Dry Basis	14	mg/kg	6010B	08/24/2005
Copper Dry Basis	20	mg/kg	6010B	08/24/2005
Iron Dry Basis	16100	mg/kg	6010B	08/24/2005
Lead Dry Basis	53	mg/kg	6010B	08/24/2005
Manganese Dry Basis	930	mg/kg	6010B	08/24/2005
Zinc Dry Basis	88	mg/kg	6010B	08/24/2005
Thallium Dry Basis	<10	mg/kg	6010B	08/24/2005
ICP/AA Batch#/Digest Date	1558	----	3050B-M	08/24/2005
ICPMS Batch#/Digest Date	1559	-----	3050B-SB	08/24/2005

Northern Analytical Laboratories, Inc.

Page 4

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: NONE GIVEN

Project Name: SPRING MEADOW BUGS & SEDIMENT

Sample No.: 2005070142-6

Description: SML 303 SD

Matrix: SEDIMENT

Date Received: 07/13/2005

Date Collected: 06/24/2005

Collected by: JOHN KOERTH

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
METALS				
Antimony Dry Basis	<5	mg/kg	6020	08/26/2005
Arsenic Dry Basis	17	mg/kg	6010B	08/24/2005
Barium Dry Basis	41	mg/kg	6010B	08/24/2005
Cadmium Dry Basis	<2	mg/kg	6010B	08/24/2005
Chromium Dry Basis	6	mg/kg	6010B	08/24/2005
Copper Dry Basis	15	mg/kg	6010B	08/24/2005
Iron Dry Basis	8420	mg/kg	6010B	08/24/2005
Lead Dry Basis	28	mg/kg	6010B	08/24/2005
Manganese Dry Basis	156	mg/kg	6010B	08/24/2005
Zinc Dry Basis	47	mg/kg	6010B	08/24/2005
Thallium Dry Basis	<10	mg/kg	6010B	08/24/2005
ICP/AA Batch#/Digest Date	1558	---	3050B-M	08/24/2005
ICPMS Batch#/Digest Date	1559	----	3050B-SB	08/24/2005

AUG 25 2005

Dept. of Environmental Quality
Remediation Division

602 South 25th Street
P O Box 30315
Billings, MT 59101
Telephone: (406) 254-7226
Fax: (406) 254-1389

REPORT TO: ATTN: JOHN KOERTH
MONTANA DEPT. OF ENVIRONMENTAL QUALITY
P.O. BOX 200901
HELENA, MT 59620-0901

DATE: August 25, 2005
JOB NUMBER: 90-933-14
PAGE: 1 of 7
INVOICE NO.: 5070142

REPORT OF: Soil/Biota Analysis – Spring Meadow Bugs & Sediment

CASE NARRATIVE:

On July 13, 2005 these soil and biota samples (laboratory numbers 2005070142-1 through -6) were received in our laboratory for analysis. Tests were conducted in accordance with SW-846 "Test Methods for Evaluating Solid Waste", 3rd Edition, updates I, II, IIA, IIB, III. The results of the sediment analysis will be reported under a separate cover when completed.

The results of the analysis are shown on the following pages. A < sign indicates the value reported was the practical quantitation limit for this sample using the method described. Concentrations of analyte, if present, below this were not quantifiable. Sample results are not corrected for analyte blank concentrations. Values in brackets are the quality control limits for the associated quality control test.

The condition of the samples upon receipt at the laboratory is noted on the attached sample receipt checklist. Chain of custody documentation is enclosed.

Reviewed by



Sara Sanderson - Project Manager

Attachments: Chain of Custody
Sample Receipt Checklist

nct

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: NONE GIVEN

Project Name: SPRING MEADOW BUGS & SEDIMENT

Sample No.: 2005070142-1	Description: SML 301 BUGS	Matrix: -----
Date Received: 07/13/2005		
Date Collected: 06/24/2005	Collected by: JOHN KOERTH	

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<0.4	mg/kg	6020	08/17/2005
Arsenic Dry Basis	0.6	mg/kg	6020	08/17/2005
Barium Dry Basis	2	mg/kg	6020	08/17/2005
Cadmium Dry Basis	0.07	mg/kg	6020	08/17/2005
Chromium Dry Basis	<0.6	mg/kg	6020	08/17/2005
Copper Dry Basis	4.4	mg/kg	6020	08/17/2005
Iron Dry Basis	1080	mg/kg	6010B	08/05/2005
Lead Dry Basis	1	mg/kg	6020	08/17/2005
Manganese Dry Basis	17	mg/kg	6020	08/19/2005
Zinc Dry Basis	12	mg/kg	6020	08/17/2005
Thallium Dry Basis	<0.1	mg/kg	6020	08/19/2005
ICPMS Batch#/Digest Date	1538	-----	3050B-M	08/15/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: NONE GIVEN

Project Name: SPRING MEADOW BUGS & SEDIMENT

Sample No.: 2005070142-2 Description: SML 302 BUGS Matrix: -----
Date Received: 07/13/2005
Date Collected: 06/24/2005 Collected by: JOHN KOERTH

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<0.4	mg/kg	6020	08/17/2005
Arsenic Dry Basis	3.9	mg/kg	6020	08/17/2005
Barium Dry Basis	5.5	mg/kg	6020	08/17/2005
Cadmium Dry Basis	0.09	mg/kg	6020	08/17/2005
Chromium Dry Basis	<0.6	mg/kg	6020	08/17/2005
Copper Dry Basis	3.0	mg/kg	6020	08/17/2005
Iron Dry Basis	1820	mg/kg	6010B	08/05/2005
Lead Dry Basis	6.2	mg/kg	6020	08/17/2005
Manganese Dry Basis	303	mg/kg	6020	08/19/2005
Zinc Dry Basis	17	mg/kg	6020	08/17/2005
Thallium Dry Basis	<0.1	mg/kg	6020	08/19/2005
ICPMS Batch#/Digest Date	1538	-----	3050B-M	08/15/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: NONE GIVEN

Project Name: SPRING MEADOW BUGS & SEDIMENT

Sample No.: 2005070142-3	Description: SML 303 BUGS	Matrix: -----
Date Received: 07/13/2005		
Date Collected: 06/24/2005	Collected by: JOHN KOERTH	

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<0.4	mg/kg	6020	08/17/2005
Arsenic Dry Basis	2.6	mg/kg	6020	08/17/2005
Barium Dry Basis	3.3	mg/kg	6020	08/17/2005
Cadmium Dry Basis	<0.06	mg/kg	6020	08/17/2005
Chromium Dry Basis	<0.6	mg/kg	6020	08/17/2005
Copper Dry Basis	4.5	mg/kg	6020	08/17/2005
Iron Dry Basis	800	mg/kg	6010B	08/05/2005
Lead Dry Basis	1	mg/kg	6020	08/17/2005
Manganese Dry Basis	98	mg/kg	6020	08/19/2005
Zinc Dry Basis	14	mg/kg	6020	08/17/2005
Thallium Dry Basis	<0.1	mg/kg	6020	08/19/2005
ICPMS Batch#/Digest Date	1538	-----	3050B-M	08/15/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: NONE GIVEN

Project Name: SPRING MEADOW BUGS & SEDIMENT

Sample No.: 2005070142-9	Description: METHOD BLANK	Matrix: WATER
Date Received: ----		
Date Collected: ----	Collected by: PREPARED BY LAB	

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	<0.003	mg/l	6020	08/17/2005
Arsenic Dry Basis	<0.003	mg/l	6020	08/17/2005
Barium Dry Basis	<0.01	mg/l	6020	08/17/2005
Cadmium Dry Basis	<0.0005	mg/l	6020	08/17/2005
Chromium Dry Basis	<0.005	mg/l	6020	08/17/2005
Copper Dry Basis	<0.005	mg/l	6020	08/17/2005
Iron Dry Basis	<0.05	mg/l	6010B	08/05/2005
Lead Dry Basis	<0.003	mg/l	6020	08/17/2005
Manganese Dry Basis	<0.005	mg/l	6020	08/19/2005
Zinc Dry Basis	<0.01	mg/l	6020	08/17/2005
Thallium Dry Basis	<0.001	mg/l	6020	08/19/2005
ICPMS Batch#/Digest Date	1538	----	3050B-M	08/15/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: NONE GIVEN

Project Name: SPRING MEADOW BUGS & SEDIMENT

Sample No.: 2005070142-10	Description: LABORATORY CONTROL	Matrix: WATER
Date Received: -----	SAMPLE	
Date Collected: -----	Collected by: PREPARED BY LAB	

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	87	% [80-120]	6020	08/17/2005
Arsenic Dry Basis	90	% [80-120]	6020	08/17/2005
Barium Dry Basis	96	% [80-120]	6020	08/17/2005
Cadmium Dry Basis	88	% [80-120]	6020	08/17/2005
Chromium Dry Basis	86	% [80-120]	6020	08/17/2005
Copper Dry Basis	96	% [80-120]	6020	08/17/2005
Iron Dry Basis	98	% [80-120]	6010B	08/05/2005
Lead Dry Basis	84	% [80-120]	6020	08/17/2005
Manganese Dry Basis	94	% [80-120]	6020	08/19/2005
Zinc Dry Basis	83	% [80-120]	6020	08/17/2005
Thallium Dry Basis	82	% [80-120]	6020	08/19/2005
ICPMS Batch#/Digest Date	1538	-----	3050B-M	08/15/2005

Client Name: MT DEPT OF ENVIROMENTAL QUALITY

Project No.: NONE GIVEN

Project Name: SPRING MEADOW BUGS & SEDIMENT

Sample No.: 2005070142-11 Description: SAMPLE DUPLICATE Matrix: -----
 Date Received: -----
 Date Collected: ----- Collected by: PREPARED BY LAB

Laboratory Test	Measured Value	Test Units	Test Method	Date of Analysis
TARGET ANALYTE LIST (SOIL)				
Antimony Dry Basis	0	RPD [0-20]	6020	08/17/2005
Arsenic Dry Basis	0	RPD [0-20]	6020	08/17/2005
Barium Dry Basis	6	RPD [0-20]	6020	08/17/2005
Cadmium Dry Basis	0	RPD [0-20]	6020	08/17/2005
Chromium Dry Basis	0	RPD [0-20]	6020	08/17/2005
Copper Dry Basis	2	RPD [0-20]	6020	08/17/2005
Iron Dry Basis	NA	-----	-----	-----
Lead Dry Basis	1	RPD [0-20]	6020	08/17/2005
Manganese Dry Basis	1	RPD [0-20]	6020	08/19/2005
Zinc Dry Basis	16	RPD [0-20]	6020	08/17/2005
Thallium Dry Basis	0	RPD [0-20]	6020	08/19/2005
ICPMS Batch#/Digest Date	1538	-----	3050B-M	08/15/2005



Chain of Custody and Analytical Request Record

Page ____ of ____

PLEASE PRINT, provide as much information as possible. Refer to corresponding notes on reverse side.

Company Name DEQ OFFICE OF THE ATTORNEY GENERAL		Project Name, PWS #, Permit #, Etc. SPRING MEADOW BUGS & SEDIMENT	
Report Mail Address 1420 E 6TH AV HELENA MT 59620		Contact Name, Phone, Fax, E-mail: DON KAAR JOHN KOERTH	
Invoice Address		Purchase Order #	
Report Required For: POTWWTP ☐ DW ☐ Other _____		Notify ELI prior to RUSH sample submittal for additional charges and scheduling Comments: 7/13/05 2005070142	
Special Report Formats - ELI must be notified prior to sample submittal for the following: NELAC ☐ A2LA ☐ Level IV ☐ Other _____ EDD/EDT ☐ Format _____		Shipped by: Cooler ID(s) _____ Receipt Temp _____ °C Custody Seal Y N Intact Y N Signature Y N Match _____ Lab ID _____	
SAMPLE IDENTIFICATION (Name, Location, Interval, etc.)		LABORATORY USE ONLY	
Collection Date		Normal Turnaround (TAT)	
Collection Time		RUSH Turnaround (TAT)	
Number of Containers		SEE ATTACHED	
Sample Type AWSBO Air Water Soils/Solids Vegetation Bioassay Other		ANALYSIS REQUESTED	
MATRIX		Arsenic Spec	
1 SML 301 BUGS		✓	
2 SML 302 BUGS		✓	
3 SML 303 BUGS		✓	
4 SML 301 SD		✓	
5 SML 302 SD		✓	
6 SML 303 SD		✓	
7 MS		✓	
8 MSD		✓	
9 MB		✓	
10 LSS Dug		✓	
Relinquished by (print) Phil Koertth		Received by (print) [Signature]	
Date/Time 7/13/05		Date/Time 7/13/05 1230	
Relinquished by (print)		Received by (print)	
Date/Time		Date/Time	
Custody Record MUST be Signed		Sample Disposal	
Return to client		Sample Type: _____ # of fractions _____	
Lab Disposal		LABORATORY USE ONLY	

In certain circumstances, samples submitted to Energy Laboratories, Inc. may be subcontracted to other certified laboratories in order to complete the analysis requested. This serves as notice of this possibility. All sub-contract data will be clearly notated on your analytical report.

SAMPLE RECEIPT CHECKLIST

Dear Valued Client: This checklist documents the condition of your sample(s) as it (they) arrived at our lab. Please review it and familiarize yourself with its contents. Should you have any questions or comments, please contact us. Thank you for your use of our services.

Client Name MDEQ Date/Time Received 7/13/05 1230
 Project Spring Meadow/Smith #3 Received by KJR
 Laboratory Number(s) 2005070142 / 143 Carrier Name Hand
 Checklist Completed by KJR 7/13/05 Sample Type Soil/Biota/Water
Initials / Date

	YES	NO		YES	NO
1. Shipping container in good condition?	☒	☐	14. pH check performed by:	<u>NA</u>	☐
2. Custody seals present on shipping container?	☐	☒	15. Metals bottle(s) pH <2?	<u>NA</u>	☐
Condition: Intact <u>NA</u> Broken <u>NA</u>			16. Nutrient bottle(s) pH <2?	☐	☐
3. Chain of custody present?	☒	☐	17. Cyanide bottle(s) pH >12?	☐	☐
4. Chain of custody signed when relinquished and received?	☒	☐	18. Sulfide bottle(s) pH >9?	☐	☐
5. Chain of custody agrees with sample labels?	☒	☐	19. TOC bottle(s) pH <2?	☐	☐
6. Custody seals on sample bottles?	☐	☒	20. Phenolics bottle(s) pH <2?	☐	☐
Condition: Intact <u>NA</u> Broken <u>NA</u>			21. Oil & grease bottle(s) pH <2? (checked by analyst)	☐	☐
7. Samples in proper container/bottle?*	☒	☐	22. EPH/DRO bottle(s) pH <2? (checked by analyst)	☐	☐
8. Sample containers intact?*	☒	☐	23. Volatiles (VOA) pH <2? (checked by analyst)	☐	☐
9. Sufficient sample volume for indicated test?*	☒	☐	24. Semivolatiles (525) pH <2? (checked by analyst)	☐	☐
10. Ice/Frozen Blue Ice present in shipping container? (circle one)	☒	☐	25. Other test types	☒	☐
container temperature 1. <u>4.8</u> 2. <u>Room Temp</u> 3. <u>Water</u>			26. Client contacted?	☐	☐
* (if <0 or >10)			27. Person contacted	☐	☐
11. All samples rec'd within holding time?*	☒	☐	28. Date contacted	☐	☐
12. VOA vials have zero headspace? (if contains >5mm headspace)	☒	☐			
13. Trip Blank received?	☒	☐			

NOTES: Samples may be affected when not transported at the temperature recommended by the EPA for the test you've selected. Please contact the lab if you have concerns about the temperature of your samples.

* Critical item - if marked "NO" contact lab manager.

COMMENTS: Containers for water are not preserved at the direction of lab manager - contents unknown
7/13/05

State of Montana
Department of Public Health and Human Services
ENVIRONMENTAL LABORATORY

Cogswell Building, Rm B219, 1400 Broadway, PO BOX 4369, Helena MT 59604 Phone 444-2642

RESULTS OF CHEMICAL ANALYSIS

DON SKAAR
FISH WILDLIFE AND PARKS
1420 E 6TH AVE
HELENA, MT 59620

Acct #: B0000075

PWSID #:

Project ID:

Collected: 07/29/2005

Time: 15:30

By: DON SKAAR

Received Date: 7/29/2005

Matrix: Fish Tissue

Report Date: 08/08/2005

RECEIVED

AUG 11 2005

FISHERIES DIV.
FISH, WILDLIFE & PARK

Lab#: C0507-2539

Sample ID: SPG MEADOW BASS / FW & P

<u>ANALYTE</u>	<u>RESULTS</u>	<u>UNITS</u>	<u>METHOD</u>	<u>DATE</u>	<u>ANALYST</u>
Arsenic	0.60	mg/kg	EPA 200.9	08/05/05	crs
Microwave Digestion	completed		EPA 3051	08/03/05	gal
Percent Moisture	79.0	%		08/03/05	gal

Reviewed by: 

FLAGS: < = less-than
> = greater-than
* = holding time exceeded

H = above EPA limit for drinking water

State of Montana
Department of Public Health and Human Services
ENVIRONMENTAL LABORATORY

Cogswell Building, Rm B219, 1400 Broadway, PO BOX 4369, Helena MT 59604 Phone 444-2642

- RESULTS OF CHEMICAL ANALYSIS -

DON SKAAR
FISH WILDLIFE AND PARKS
1420 E 6TH AVE
HELENA, MT 59620

Acct #: B0000075
PWSID #:
Project ID:
Collected: 07/29/2005
Time: 15:30
By: DON SKAAR
Received Date: 7/29/2005
Matrix: Fish Tissue
Report Date: 08/08/2005

Lab#: C0507-2540

Sample ID: SPG MEADOW PUMPKINSEED / FW & P

<u>ANALYTE</u>	<u>RESULTS</u>	<u>UNITS</u>	<u>METHOD</u>	<u>DATE</u>	<u>ANALYST</u>
Arsenic	0.30	mg/kg	EPA 200.9	08/05/05	crs
Microwave Digestion	completed		EPA 3051	08/03/05	gal
Percent Moisture	76.9	%		08/03/05	gal

Reviewed by:



FLAGS: < = less-than
> = greater-than
* = holding time exceeded

H = above EPA limit for drinking water

SPRING MEADOW

7-29-05

BASS

PUMPKINSEED

L	W		L	W	
11.6	.87	U♂	6.7	.31	U♂ ⁺ STAWN
11.2	.68	U♂ ⁺	6.1	.22	U♂ ⁺ about
10.6	.61	U♂ ⁺	5.4	.16	G♂
9.5	.52	U♂ ⁺	5.3	.13	G♂ ⁺
9.1	.46	U♂	4.6	.10	U♂ ⁺

APPENDIX 5-C

RISK ASSESSMENT SPREADSHEETS AND DATA

SPRING MEADOW LAKE SITE
Surface/Subsurface Solid Matrix and Sediment Metal Concentrations (mg/kg)

Sample #	Depth (in)	Sb	As	Ba	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Ag	Zn
		31	40	5400	37	210	3100	23000	400	1800	0	1600	390	23000
Residential PRGs														
TP 151	0-6	< 5	219	112	2	12	29	18300	154	3750	< 0.5	6	< 5	356
TP 152	0-8	< 5	54	56	10	74	17	94400	140	2240	< 0.5	9	< 25	81
TP 153 A	0-6	< 5	329	102	3	26	45	33200	247	4620	< 0.5	8	< 5	345
TP 153 B	18-24	< 5	50	71	10	52	18	62500	89	1490	< 0.5	7	< 25	106
TP 154 A	8-18	22	879	264	8	31	144	25000	998	41400	0.5	8	14	1460
TP 154 B	60-66	< 5	44	31	2	10	15	14200	72	446	< 0.5	5	< 5	77
TP 155 A	0-4	17	434	289	5	33	126	20000	677	41700	< 0.5	6	12	1260
TP 155 B	18-24	< 5	37	80	2	16	24	21100	75	425	< 0.5	10	< 5	87
TP 156 A	10-12	< 5	101	85	2	11	35	17000	83	1070	< 0.5	8	< 5	116
TP 156 B	36-42	9	624	224	6	12	77	18000	572	5340	0.6	8	< 5	908
TP 157 A	4-6	< 5	180	149	3	11	37	16600	146	3030	< 0.5	10	< 5	530
TP 157 B	24-36	< 5	45	133	2	13	20	17700	37	292	< 0.5	9	< 5	62
TP 158 A	6-9	22	1460	422	17	35	218	15600	1310	111000	0.6	5	27	3380
TP 158 B	28-32	< 5	62	75	2	14	24	17600	76	1420	< 0.5	7	< 5	109
TP 159 A	4-6	15	1290	232	17	16	123	18000	926	29100	< 0.5	6	13	2260
TP 160 A	4-6	61	5400	465	41	28	377	24000	3330	85500	0.9	5	50	5730
TP 161 A	0-6	13	804	106	8	14	74	17400	614	12100	< 0.5	5	6	841
TP 162 A	0-2	7	126	150	2	16	61	18600	269	15000	< 0.5	5	< 5	603
TP 162 B	36-42	< 5	100	161	2	19	73	24500	115	1730	0.6	15	< 5	187
TP 163 A	0-6	< 5	172	155	2	11	113	19400	189	5220	< 0.5	10	< 5	274
TP 164 A	0-4	23	754	539	12	40	241	15200	1220	122000	0.5	5	30	2680
TP 164 B	16-24	5	461	196	8	17	104	29700	373	4230	< 0.5	12	< 5	1200
TP 165 A	4-6	6	502	136	4	18	66	22900	389	12200	< 0.5	6	< 5	566
TP 166 A	0-4	12	570	194	5	14	102	15800	537	27900	< 0.5	5	8	1130
TP 166 B	12-18	< 5	26	44	2	5	10	7840	20	347	< 0.5	5	< 5	36
TP 167 A	14-20	93	10400	494	13	18	265	22400	6180	53200	0.6	5	54	2490
TP 167 B	22-24	< 5	101	57	2	12	25	15600	82	1210	< 0.5	5	< 5	97
TP 168 A	2-6	< 5	37	50	2	11	19	15600	37	338	< 0.5	8	< 5	62
TP 168 B	18-24	< 5	21	58	2	8	12	13200	30	644	< 0.5	5	< 5	48
TP 168 C	26-60	< 5	110	123	2	13	49	21500	108	1030	< 0.5	10	< 5	136
TP 169 A	0-6	11	781	202	6	13	103	19100	590	24700	< 0.5	7	7	1050
TP 169 B	6-18	10	609	200	5	15	92	21300	496	22800	< 0.5	7	< 5	911
TP 170 A	4-6	< 5	10	46	2	13	19	16300	18	340	< 0.5	7	< 5	52
TP 170 B	20-28	47	50	78	10	32	99	103000	567	952	< 0.5	22	< 25	78
TP 170 C	32-38	< 5	61	140	2	10	29	14900	60	444	< 0.5	7	< 5	83
TP 171 A	2-12	280	33700	581	78	17	1290	61200	16300	60000	2.1	5	106	5940
TP 171 B	12-20	< 5	59	98	10	21	46	71900	60	1260	< 0.5	17	< 25	92
TP 171 C	30-36	< 5	43	142	2	12	24	16400	31	305	< 0.5	9	< 5	53
TP 172 A	18-20	< 5	30	64	2	10	21	15000	52	333	< 0.5	6	< 5	76
TP 173 A	0-9	9	158	773	14	48	350	18000	1290	224000	< 0.5	5	31	3370
TP 173 B	10-20	21	1240	343	246	24	253	53100	3010	36900	0.7	11	15	48400
TP 173 C	22-24	< 5	54	172	2	10	22	15000	27	448	< 0.5	9	< 5	93
TP 174 A	0-8	< 5	76	180	4	17	53	19300	298	18000	< 0.5	9	< 5	1050
TP 174 B	14-16	< 5	65	79	2	11	24	17800	55	391	< 0.5	8	< 5	80
TP 174 C	18-20	< 5	11	79	2	10	65	32600	84	396	< 0.5	12	< 5	69
TP 174 D	30-32	< 5	39	127	2	13	22	18200	33	407	< 0.5	9	< 5	89
Sediment Goals		2.9	19		7.5				240	1400	0.16	39		500
SD 201	0-2	< 5	95	77	2	8	25	10800	135	3650	< 0.5	5	< 5	198
SD 202	0-2	< 5	34	54	2	7	19	9550	53	384	< 0.5	5	< 5	83
SD 203	0-2	< 5	19	52	2	10	15	9840	64	159	< 0.5	5	< 5	82
SD 204	0-2	< 5	32	116	2	10	42	9560	163	586	< 0.5	5	< 5	218
SD 205	0-2	< 5	31	120	2	10	38	14300	130	323	< 0.5	7	< 5	185
SD 206	0-2	< 5	20	98	2	6	24	6420	70	173	< 0.5	5	< 5	93
SD 207	0-2	< 5	105	121	2	5	39	6940	70	814	< 0.5	5	< 5	314
SD 208	0-2	< 5	110	130	6	13	78	14800	319	1370	0.6	7	< 5	619
SML 301	0-4	< 5	15	36	2	6	13	7800	27	122	NA	NA	NA	46
SML 302	0-4	< 5	50	55	2	14	20	16100	53	930	NA	NA	NA	88
SML 303	0-4	< 5	17	41	2	6	15	8420	28	156	NA	NA	NA	47

Notes:

Sb = Antimony; As = Arsenic; Ba = Barium; Cd = Cadmium; Cr = Chromium; Cu = Copper
Fe = Iron; Pb = Lead; Hg = Mercury; Ni = Nickel; Ag = Silver; Zn = Zinc
TP Test Pit
SD Sediment
NA Not Analyzed For

SPRING MEADOW LAKE SITE

Surface Water (SW) and Groundwater (MW) Metal Concentrations (mg/L)

	Antimony	Arsenic	Barium	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Silver	Zinc
WQB-7 Total	0.006	0.018	2.000	0.005	0.100	1.300	0.300	0.015	0.050	5E-05	0.100	0.100	2.000
SW 201	< 0.003	0.012	0.029	< 0.0001	<0.001	< 0.001	0.02	< 0.003	0.005	< 0.0006	0.02	< 0.003	< 0.01
SW 202	< 0.003	0.012	0.037	< 0.0001	<0.001	< 0.001	0.02	< 0.003	0.011	< 0.0006	0.02	< 0.003	< 0.01
SW 203	< 0.003	0.032	0.009	< 0.0001	<0.001	< 0.001	0.06	< 0.003	0.051	< 0.0006	0.02	< 0.003	< 0.01
WQB-7 Dis.	0.006	0.020	2.000	0.005	0.100	1.300	0.300	0.015	0.050	0.002	0.100	0.100	2.000
MW 1	< 0.003	0.029	0.041	0.0001	0.008	0.005	< 0.01	< 0.003	0.390	< 0.0006	< 0.02	< 0.003	< 0.01
MW 2	< 0.003	0.010	0.043	0.0004	0.008	0.002	< 0.01	< 0.003	0.007	< 0.0006	< 0.02	< 0.003	0.04

SPRING MEADOW LAKE SITE

Aquatic Invertebrates (Bugs) and Fish (Bass and Pumpkinseed) Metal Concentrations (mg/kg)

	Antimony	Arsenic	Barium	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Silver	Zinc
USDI 1998 ^a		30-50											
SML 301 Bugs	< 0.4	0.6	2	0.07	<0.6	4.4	1080	1	17	NA	NA	NA	12
SML 302 Bugs	< 0.4	3.9	5.5	0.09	<0.6	3	1820	6.2	303	NA	NA	NA	17
SML 303 Bugs	< 0.4	2.6	3.3	<0.06	<0.6	4.5	800	1	98	NA	NA	NA	14
Gilderhus 1966 ^b		1 - 3											
SPG Bass		0.60											
SPG Pumpkinseed		0.30											

Notes:

^a USDI, 1998. Guidelines for Interpretation of the Biological Effects of Selected Constituents in Biota, Water, and Sediment – Arsenic

^b Gilderhus, 1966. Some Effects of Sublethal Concentrations of Sodium Arsenite on Bluegills and the Aquatic Environment.

SPRING MEADOW LAKE SITE - East Arm Area

Surface/Subsurface Solid Matrix Metal Concentrations (mg/kg)

Sample #	Depth (in)	Sb	As	Ba	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Ag	Zn
Residential PRGs		31	40	5400	37	210	3100	23000	400	1800	0	1600	390	23000
TP 151	0-6	<	219	112	2	12	29	18300	154	3750	<	0.5	6	356
TP 152	0-8	<	54	56	10	74	17	94400	140	2240	<	0.5	9	81
TP 153 A	0-6	<	329	102	3	26	45	33200	247	4620	<	0.5	8	345
TP 153 B	18-24	<	50	71	10	52	18	62500	89	1490	<	0.5	7	106
TP 154 A	8-18	<	879	264	8	31	144	25000	998	41400	<	0.5	8	1460
TP 154 B	60-66	<	44	31	2	10	15	14200	72	446	<	0.5	5	77
TP 155 A	0-4	<	434	289	5	33	126	20000	677	41700	<	0.5	6	12
TP 155 B	18-24	<	37	80	2	16	24	21100	75	425	<	0.5	10	87
TP 156 A	10-12	<	101	85	2	11	35	17000	83	1070	<	0.5	8	116
TP 156 B	36-42	<	624	224	6	12	77	18000	572	5340	<	0.6	8	908
TP 157 A	4-6	<	180	149	3	11	37	16600	146	3030	<	0.5	10	530
TP 157 B	24-36	<	45	133	2	13	20	17700	37	292	<	0.5	9	62
TP 158 A	6-9	<	1460	422	17	35	218	15600	1310	111000	<	0.6	5	3380
TP 158 B	28-32	<	62	75	2	14	24	17600	76	1420	<	0.5	7	109
TP 159 A	4-6	<	1290	232	17	16	123	18000	926	29100	<	0.5	6	13
TP 160 A	4-6	<	5400	465	41	28	377	24000	3330	85500	<	0.9	5	50
TP 161 A	0-6	<	804	106	8	14	74	17400	614	12100	<	0.5	5	841
TP 162 A	0-2	<	126	150	2	16	61	18600	269	15000	<	0.5	5	603
TP 162 B	36-42	<	100	161	2	19	73	24500	115	1730	<	0.6	15	187
TP 163 A	0-6	<	172	155	2	11	113	19400	189	5220	<	0.5	10	274
TP 164 A	0-4	<	754	539	12	40	241	15200	1220	122000	<	0.5	5	30
TP 164 B	16-24	<	461	196	8	17	104	29700	373	4230	<	0.5	12	1260
TP 165 A	4-6	<	502	136	4	18	66	22900	389	12200	<	0.5	6	566
TP 166 A	0-4	<	570	194	5	14	102	15800	537	27900	<	0.5	5	1130
TP 166 B	12-18	<	26	44	2	5	10	7840	20	347	<	0.5	5	36
TP 167 A	14-20	<	10400	494	13	18	265	22400	6180	53200	<	0.6	5	54
TP 167 B	22-24	<	101	57	2	12	25	15600	82	1210	<	0.5	5	97
TP 168 A	2-6	<	37	50	2	11	19	15600	37	338	<	0.5	8	62
TP 168 B	18-24	<	21	58	2	8	12	13200	30	644	<	0.5	5	48
TP 168 C	26-60	<	110	123	2	13	49	21500	108	1030	<	0.5	10	136
TP 169 A	0-6	<	781	202	6	13	103	19100	590	24700	<	0.5	7	1050
TP 169 B	6-18	<	609	200	5	15	92	21300	496	22800	<	0.5	7	911
SD		18 17	1994 6	134 78	7 6958	14 24	85 153	15860	1194 7	31882	0 0762	2 4363	12 891	1237 8
alpha 05		5 252	576 4	38 95	2 2239	4 115	24 608	4583 2	345 25	9213 2	0 022	0 704	3 7253	357 7
average		12 88	836 94	176 72	6 5313	19 938	85 563	22914	630 66	19921	0 525	7 25	11 594	913 69
95%UCL		18 13	1413 3	215 67	8 7552	24 053	110 17	27497	975 91	29134	0 547	7 954	15 319	1271 4
max		93	10400	539	41	74	377	94400	6180	122000	0 9	15	54	5730
min		5	21	31	2	5	10	7840	20	292	0 5	5	5	36

SPRING MEADOW LAKE SITE - Montana Wildlife Center

Surface/Subsurface Solid Matrix Metal Concentrations (mg/kg)

Sample #	Depth (in)	Sb	As	Ba	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Ag	Zn
Industrial Soil	PRG	410	260	67,000	450	450	41,000	100,000	750	19,000	0	20,000	5,100	100,000
TP 170 A	4-6	<	5 <	46 <	2	13	19	16300	18	340 <	0.5	7 <	5	52
TP 170 B	20-28	<	47 <	78 <	10	32	99	103000	567	952 <	0.5	22 <	25	78
TP 170 C	32-38	<	5	140 <	2	10	29	14900	60	444 <	0.5	7 <	5	83
TP 171 A	2-12	280	33700	581	78	17	1290	61200	16300	60000	2.1	5	106	5940
TP 171 B	12-20	<	5	98 <	10	21	46	71900	60	1260 <	0.5	17 <	25	92
TP 171 C	30-36	<	5	142 <	2	12	24	16400	31	305 <	0.5	9 <	5	53
TP 172 A	18-20	<	5	64 <	2	10	21	15000	52	333 <	0.5	6 <	5	76
TP 173 A	0-9	9	158	773	14	48	350	18000	1290	224000 <	0.5	5	31	3370
TP 173 B	10-20	21	1240	343	246	24	253	53100	3010	36900	0.7	11	15	48400
TP 173 C	22-24	<	5	172 <	2	10	22	15000	27	448 <	0.5	9 <	5	93
TP 174 A	0-8	<	5	180	4	17	53	19300	298	18000 <	0.5	9 <	5	1050
TP 174 B	14-16	<	5	79 <	2	11	24	17800	55	391 <	0.5	8 <	5	80
TP 174 C	18-20	<	5	79 <	2	10	65	32600	84	396 <	0.5	12 <	5	69
TP 174 D	30-32	<	5	127 <	2	13	22	18200	33	407 <	0.5	9 <	5	89
SD		73.14	8973.4	215.45	66.122	10.859	338.53	27731.2	4320.2	60131	0.4268	4.714	27.088	12822.1
alpha .05		21.14	2593.1	62.262	19.108	3.138	97.83	8013.8	1248.5	17377	0.1234	1.362	7.8281	3705.34
average		29.07	2542.6	207.29	27	17.714	165.5	33764.3	1563.2	24584	0.6286	9.714	17.643	4251.79
95%UCL		50.21	5135.7	269.55	46.108	20.852	263.33	41778.1	2811.7	41961	0.7519	11.08	25.471	7957.12
min		5	10	46	2	10	19	14900	18	305	0.5	5	5	52
max		280	33700	773	246	48	1290	103000	16300	224000	2.1	22	106	48400

SPRING MEADOW LAKE SITE

Surface Solid Matrix (ONLY) Metal Concentrations (mg/kg)

Sample #	Depth (in)	Sb	As	Ba	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Ag	Zn
Residential PRGs		31	40	5400	37	210	3100	23000	400	1800	0	1600	390	23000
TP 104 A	0-6		2910				224		2410	27300				3700
SS 206 A	0-2		2430				327		2160	176000				5020
SS 207 A	0-2		2200				312		2120	170000				4310
SS 216 A	0-6		1520				210		1340	70100				2640
SS 204 A	0-6		302				108		468	6180				1010
TP 151	0-6	5	219	112	2	12	29	18300	154	3750	0.5	6	5	356
TP 152	0-8	5	54	56	10	74	17	94400	140	2240	0.5	9	25	81
TP 153 A	0-6	5	329	102	3	26	45	33200	247	4620	0.5	8	5	345
TP 155 A	0-4	17	434	289	5	33	126	20000	677	41700	0.5	6	12	1260
TP 161 A	0-6	13	804	106	8	14	74	17400	614	12100	0.5	5	6	841
TP 162 A	0-2	7	126	150	2	16	61	18600	269	15000	0.5	5	5	603
TP 163 A	0-6	5	172	155	2	11	113	19400	189	5220	0.5	10	5	274
TP 164 A	0-4	23	754	539	12	40	241	15200	1220	122000	0.5	5	30	2680
TP 166 A	0-4	12	570	194	5	14	102	15800	537	27900	0.5	5	8	1130
TP 169 A	0-6	11	781	202	6	13	103	19100	590	24700	0.5	7	7	1050
TP 173 A	0-9	9	158	773	14	48	350	18000	1290	224000	0.5	5	31	3370
TP 174 A	0-8	5	76	180	4	17	53	19300	298	18000	0.5	9	5	1050
Average		9.75	814.06	238.17	6.0833	26.5	146.76	25725	866.06	55930	0.5	6.6667	12	1748.2
Maximum		23	2910	773	14	74	350	94400	2410	224000	0.5	10	31	5020
Minimum		5	54	56	2	11	17	15200	140	2240	0.5	5	5	81

Surface/Subsurface Solid Matrix and Sediment Metal Concentrations
(mg/kg) PA&RI

Sample #	PA or RI	Depth (in)	As	Cu	Mn	Pb	Zn
Residential PRGs			40	3100	1800	400	23000
Sediment Goals			19	840	1400	240	500
TP 153 B	RI	18-24	<50	18	1490	89	106
TP 170 B	RI	20-28	<50	99	952	567	78
TP 170 A	RI	4-6	<10	19	340	18	52
TP 129 C	PA	144	57500	3300	949	28600	29700
TP 111 A	PA	24	34200	905	1370	23100	10900
TP 171 A	RI	2-12	33700	1290	60000	16300	5940
TP 127 B	PA	48	27700	1390	21000	39000	16000
TP 126 A	PA	12	20700	220	8290	5220	4240
TP 161 A	RI	14-20	10400	265	53200	6180	2490
TP 119 A	PA	12	8980	443	111000	5840	6020
TP 115 B	PA	24	5890	516	43700	4260	2150
TP 160 A	RI	4-6	5400	377	85500	3330	5730
TP 128 B	PA	24	3280	232	120000	1920	4120
TP 120 A	PA	12	2920	390	220000	2480	5580
TP 124 A	PA	0-6	2910	224	27300	2410	3790
TP 124 B	PA	18	2640	240	34400	2320	3600
SS 106 A	PA	0-2	2430	327	176000	2160	5020
SS 107 A	PA	0-2	2200	312	170000	2120	4310
SS 216 A	PA	0-6	1520	210	70100	1340	2640
TP 158 A	RI	6-9	1460	218	111000	1310	3380
TP 159 A	RI	4-6	1290	123	29100	926	2260
TP 107 C	PA	60	1250	505	228000	2730	7940
TP 173 B	RI	10-20	1240	253	36900	3010	48400
TP 127 B	PA	24	1240	95	16800	690	1710
TP 116 C	PA	54	951	83	24500	915	1000
TP 154 A	RI	8-18	879	144	41400	998	1460
TP 161 A	RI	0-6	804	74	12100	614	841
TP 169 A	RI	0-6	781	103	24700	590	1050
TP 164 A	RI	0-4	754	241	122000	1220	2680
TP 156 B	RI	36-42	624	77	5340	572	908
TP 169 B	RI	6-18	609	92	22800	496	911
TP 166 A	RI	0-4	570	102	27900	537	1130
TP 165 A	RI	4-6	502	66	12200	389	566
TP 164 B	RI	16-24	461	104	4230	373	1260
TP 113 A	PA	12	451	175	1410	819	4180
TP 155 A	RI	0-4	434	126	41700	677	1260
TP 153 A	RI	0-6	329	45	4620	247	345
SS 204 A	PA	0-6	302	108	6180	468	1010
TP 120 B	PA	36	222	424	191000	1970	4280
TP 151 A	RI	0-6	219	29	3750	154	356
TP 151 A	RI	4-6	180	37	3030	146	530
TP 123 A	RI	0-6	172	113	5220	189	274
TP 127 C	PA	48	163	41	1250	95	172
TP 173 A	RI	0-9	158	350	224000	1290	3370
TP 162 A	RI	0-2	126	61	15000	269	603
SD 208 A	RI	0-2	110	78	1370	319	619
TP 168 C	RI	26-60	110	49	1030	108	136
SD 207 A	RI	0-2	105	39	814	70	314
TP 167 B	RI	22-24	101	25	1210	82	97
TP 156 A	RI	10-12	101	35	1070	83	116
TP 162 B	RI	36-42	100	73	1730	115	187
SD 201 A	RI	0-2	95	25	3650	135	198
TP 174 A	RI	0-8	76	53	18000	298	1050
TP 174 B	RI	14-16	65	24	391	55	80
TP 158 B	RI	28-32	62	24	1420	76	109
TP 170 C	RI	32-38	61	29	444	60	83
TP 171 B	RI	12-20	59	46	1260	60	92
TP 152 C	RI	0-8	54	17	2240	140	81
TP 173 C	RI	22-24	54	22	448	27	93
TP 157 B	RI	24-36	45	20	292	37	62
TP 154 B	RI	60-66	44	15	446	72	77
TP 171 C	RI	30-36	43	24	305	31	53
TP 174 C	RI	30-32	39	22	407	33	89
TP 155 B	RI	18-24	37	24	425	75	87
TP 168 A	RI	2-6	37	19	338	37	62
SD 202 A	RI	0-2	34	19	384	53	80
SD 204 A	RI	0-2	32	42	586	163	218
SD 205 A	RI	0-2	31	38	323	130	185
TP 172 A	RI	18-20	30	21	333	52	76
TP 166 B	RI	12-18	26	<10	347	20	36
TP 169 B	RI	18-24	21	12	644	30	48
SD 206 A	RI	0-2	20	24	173	70	93
SD 203 A	RI	0-2	19	15	159	64	82
TP 174 C	RI	18-20	11	65	396	84	69

Surface/Subsurface Solid Matrix and Sediment Metal Concentrations
(mg/kg) PA&RI

Sample #					PA or RI	Depth (in)	As	Cu	Mn	Pb	Zn
Residential PRGs							40	3100	1800	400	23000
Sediment Goals							19	840	1400	240	500
TP	104	A	PA	0-6			2910	224	27300	2410	3700
SS	206	A	PA	0-2			2430	327	176000	2160	5020
SS	207	A	PA	0-2			2200	312	170000	2120	4310
SS	216	A	PA	0-6			1520	210	70100	1340	2640
SS	204	A	PA	0-6			302	108	6180	468	1010

CANCER RISKS VIA INGESTION OF SOIL ON SITE WORKER SCENARIO

INPUT							Conversion Factors	
Recreational Scenario	Ingestion Rate (ING) (mg/day)	Exposure Frequency (EF) (days/year)	Exposure Duration (ED) (years)	Body Weight (BW) (kg)	Averaging Time (AT) (years)	Mass (MCF) (kg/mg)	Time (TCF) (days/year)	
Average Exposure	100	165	25	70	70	1E-06	365	

INPUT				OUTPUT	
Chemicals of Potential Concern (COPCs)	Concentrations (CS)		Toxicity Values		Average Exposure
	Site Concentrations (mg/kg)			Slope Factor (mg/kg-day) ⁻¹	ADD (mg/kg-day) Cancer Risk (CR)
RECREATIONAL SCENARIO					
Arsenic	5136.0			1.5	1.2E-03
RECREATIONAL SCENARIO CR SUBTOTAL					1.8E-03

Notes:

Enter "NA" for CS or toxicity values if they are not available

NA = not available

Average CS includes one-half the sample quantitation limit for COPCs that are undetected

mg/day - milligrams per day
kg = kilograms
kg/mg - kilograms per milligram
mg/kg - milligrams per kilogram
mg/kg-day - milligrams per kilogram per day

CANCER RISKS VIA INHALATION OF DUST
ON SITE WORKER SCENARIO

INPUT								
	Inhalation Rate (INH) (m ³ /day)	Particulate Concentration (PC) (mg/m ³)	Exposure Frequency (EF) (days/year)	Exposure Duration (ED) (years)	Body Weight (BW) (kg)	Averaging Time (AT) (years)	Conversion Factors	
							Mass (MCF) (kg/mg)	Time (TCF) (days/year)
Recreational Scenario								
Average Exposure	20	0.00076	16 ²	25	70	70	11-06	365

INPUT				OUTPUT	
Chemicals of Potential Concern (COPCs)	Concentrations (CS)	Toxicity Values		Average Exposure	
	Site Concentrations (mg/kg)		Slope Factor (mg/kg-day) ⁻¹	ADD (mg/kg-day)	Cancer Risk (CR)
RECREATIONAL SCENARIO					
Arsenic	5136.0		15	1.8E-07	2.7E-06
RECREATIONAL SCENARIO CR SUBTOTAL				2.7E-06	

Notes:

Enter "NA" for CS or toxicity values if they are not available

NA = not available

Average CS includes one-half the sample quantitation limit for COPCs that are undetected

Particulate concentration is equal to a particulate emission factor of 1.1E+9 m³/kg

m³/day = cubic meters per day

mg/m³ = milligrams per cubic meter

kg = kilograms

kg/mg = kilograms per milligram

mg/kg = milligrams per kilogram

mg/kg-day = milligrams per kilogram per day

**CANCER RISKS VIA DERMAL CONTACT WITH SOIL
ON SITE WORKER SCENARIO**

INPUT								
Recreational Scenario	Surface Area (SA) (cm ² /day)	Adherence Factor (AF) (mg/cm ²)	Exposure Frequency (F+) (days/year)	Exposure Duration (E:D) (years)	Body Weight (BW) (kg)	Averaging Time (AT) (years)	Conversion Factors	
							Mass (MCF) (kg/mg)	Time (TCT) (days/year)
Average Exposure	5,700	0.15	165	25	70	70	11-06	365

INPUT				OUTPUT	
Chemicals of Potential Concern (COPCs)	Concentrations (CS)	Absorption Factor (ABS) (percent)	Toxicity Values		Average Exposure
	Site Concentrations (mg/kg)		Slope Factor (mg/kg-day) ⁻¹	Cancer Risk (CR)	
RECREATIONAL SCENARIO					
Arsenic	5136.0	0.03	1.5	3.0E-04	4.6E-04
RECREATIONAL SCENARIO CR SUBTOTAL				4.6E-04	

Notes:

Enter "NA" for CS or toxicity values if they are not available

NA = not available

Average CS includes one-half the sample quantitation limit for COPCs that are undetected

cm²/day square centimeters per day
 mg/cm² milligrams per square centimeter
 kg kilograms
 kg/mg kilograms per milligram
 mg/kg milligrams per kilogram
 mg/kg-day milligrams per kilogram per day

ON SITE WORKER SCENARIO
PATHWAY-SPECIFIC AND CHEMICAL-SPECIFIC CANCER RISK

INPUT				OUTPUT
Chemicals of Potential Concern	Cancer Risk - Recreational Scenario			<i>Chemical-Specific Cancer Risk</i>
	Ingestion of Soil	Inhalation of Dust	Dermal Contact with Soil	
	Exposure Risk	Exposure Risk	Exposure Risk	
Arsenic	1.8E-03	2.7E-06	4.6E-04	Total Exposure Risk 2.2E-03
Pathway-Specific Cancer Risk:	1.8E-03	2.7E-06	4.6E-04	2.2E-03
Recreational Scenario Cumulative Cancer Risk				

HAZARD QUOTIENTS VIA INGESTION OF SOIL ON SITE WORKER SCENARIO

INPUT							Conversion Factors	
Recreational Scenario	Ingestion Rate (ING) (mg/day)	Exposure Frequency (EF) (days/year)	Exposure Duration (ED) (years)	Body Weight (BW) (kg)	Averaging Time (AT) (years)	Mass (MCF) (kg/mg)	Time (TCF) (days/year)	
Average Exposure	100	165	25	70	25	1E-06	365	

INPUT			OUTPUT		
Chemicals of Potential Concern (COPCs)	Concentrations (C/S)		Toxicity Values Reference Dose (mg/kg-day)	Average Exposure	
	Site Concentrations (mg/kg)			ADD (mg/kg-day)	Hazard Quotient (HQ)
RECREATIONAL SCENARIO					
Arsenic	5136.0		0.0003	3.3E-03	1.1E+01
RECREATIONAL SCENARIO HQ SUBTOTAL				1.1E+01	

Notes:

Enter "NA" for CS or toxicity values if they are not available

NA = not available

Average CS includes one-half the sample quantitation limit for COPCs that are undetected

mg/day – milligrams per day

kg – kilograms

kg/mg – kilograms per milligram

mg/kg – milligrams per kilogram

mg/kg-day – milligrams per kilogram per day

HAZARD QUOTIENTS VIA INHALATION OF DUST ON SITE WORKER SCENARIO

INPUT						
Recreational Scenario	Inhalation Rate (INH) (m ³ /day)	Particulate Concentration (PC) (mg/m ³)	Exposure Frequency (EF) (days/year)	Exposure Duration (ED) (years)	Body Weight (BW) (kg)	Averaging Time (AT) (years)
Average Exposure	20	0.00076	165	25	70	25
						11-06
						365

INPUT			OUTPUT	
Chemicals of Potential Concern (COPCs)	Concentrations (CS)		Toxicity Values	
	Site Concentrations (mg/kg)		Average Exposure ADD (mg/kg-day)	Hazard Quotient (HQ)
RECREATION-41 SCENARIO				
Arsenic	5136.0		5.01E-07	NA
RECREATION-41 SCENARIO HQ SUBTOTAL				
				NA

Notes

Enter "NA" for CS or toxicity values if they are not available

NA = not available

Average CS includes one-half the sample quantitation limit for COPCs that are undetected

m³/day = cubic meters per day

mg/m³ = milligrams per cubic meter

kg = kilograms

kg/mg = kilograms per milligram

mg/kg = milligrams per kilogram

mg/kg-day = milligrams per kilogram per day

HAZARD QUOTIENTS VIA DERMAL CONTACT WITH SOIL ON SITE WORKER SCENARIO

INPUT							Conversion Factors	
Recreational Scenario	Surface Area (SA) (cm ² /day)	Adherence Factor (AF) (mg/cm ²)	Exposure Frequency (EF) (days/year)	Exposure Duration (ED) (years)	Body Weight (BW) (kg)	Averaging Time (AT) (years)	Mass (MCF) (kg/mg)	Time (TCF) (days/year)
Average Exposure	5,700	0.15	165	25	70	25	1E-06	365

INPUT				OUTPUT		
Chemicals of Potential Concern (COPCs)	Concentrations (C'S)		Absorption Factor (ABS) (percent)	Toxicity Values Reference Dose (mg/kg-day)	Average Exposure	
	Site Concentrations (mg/kg)				ADD (mg/kg-day)	Hazard Quotient (HQ)
RECREATIONAL SCENARIO						
Arsenic	5136.0		0.03	0.0003	8.5E-04	2.8E+00
RECREATIONAL SCENARIO HQ SUBTOTAL						
					2.8E+00	

Notes:

Enter "NA" for CS or toxicity values if they are not available

NA – not available

Average CS includes one-half the sample quantitation limit for COPCs that are undetected

cm²/day = square centimeters per day
 mg/cm² = milligrams per square centimeter
 kg = kilograms
 kg/mg – kilograms per milligram
 mg/kg – milligrams per kilogram
 mg/kg-day = milligrams per kilogram per day

ON SITE WORKER SCENARIO
PATHWAY-SPECIFIC AND CHEMICAL-SPECIFIC HAZARD INDICES

INPUT				OUTPUT
Chemicals of Potential Concern	Hazard Quotient - Recreational Scenario			<i>Chemical-Specific Hazard Index</i>
	Ingestion of Soil	Inhalation of Dust	Dermal Contact with Soil	
	Exposure Risk	Exposure Risk	Exposure Risk	
Arsenic	1.1E+01	0.0E+00	2.8E+00	Total Exposure Risk 1.4E+01
<i>Pathway-Specific Hazard Index:</i>	1.1E+01	0.0E+00	2.8E+00	1.4E+01
<i>Recreational Scenario Cumulative Hazard Index</i>				

SPRING MEADOW LAKE SITE

LEAD RISK ASSESSMENT SPREADSHEET

CALIFORNIA DEPARTMENT OF TOXIC SUBSTANCES CONTROL

10/12/2005

USER'S GUIDE to version 7

INPUT	
MEDIUM	LEVEL
Lead in Air (ug/m ³)	0.028
Lead in Soil/Dust (ug/g)	976.0
Lead in Water (ug/l)	5
% Home-grown Produce	0%
Respirable Dust (ug/m ³)	0.76

OUTPUT							
	Percentile Estimate of Blood Pb (ug/dl)					PRG-99	PRG-95
	50th	90th	95th	98th	99th	(ug/g)	(ug/g)
BLOOD Pb, ADULT	0.6	1.2	1.4	1.7	1.9	21482	31214
BLOOD Pb, CHILD	1.5	2.8	3.3	4.0	4.5	3684	5586
BLOOD Pb, PICA CHILD	1.8	3.4	4.0	4.9	5.5	2456	3724
BLOOD Pb, OCCUPATIONAL	1.3	2.4	2.8	3.4	3.9	3560	5182

EXPOSURE PARAMETERS			
	units	adults	children
Days per week	days/wk	0.5	
Days per week, occupational		3	
Geometric Standard Deviation		1.6	
Blood lead level of concern (ug/dl)		10	
Skin area, residential	cm ²	5700	3700
Skin area occupational	cm ²	5700	
Soil adherence	ug/cm ²	150	200
Dermal uptake constant	(ug/dl)/(ug/d)	0.0001	
Soil ingestion	mg/day	100	133
Soil ingestion, pica	mg/day		200
Ingestion constant	(ug/dl)/(ug/d)	0.04	0.16
Bioavailability	unitless	0.44	
Breathing rate	m ³ /day	20	4.8
Inhalation constant	(ug/dl)/(ug/d)	0.082	0.192
Water ingestion	l/day	1.4	0.4
Food ingestion	kg/day	1.9	1.1
Lead in market basket	ug/kg	3.1	
Lead in home-grown produce	ug/kg	0.0	

PATHWAYS						
ADULTS	Residential			Occupational		
	Pathway contribution			Pathway contribution		
	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	5.9E-6	0.01	1%	3.5E-5	0.03	3%
Soil Ingestion	1.3E-4	0.12	19%	7.5E-4	0.74	56%
Inhalation, bkgrnd		0.00	1%		0.02	2%
Inhalation	8.9E-8	0.00	0%	5.3E-7	0.00	0%
Water Ingestion		0.28	43%		0.28	21%
Food Ingestion, bkgrnd		0.23	36%		0.23	18%
Food Ingestion	0.0E+0	0.00	0%			0%

CHILDREN	typical			with pica		
	Pathway contribution			Pathway contribution		
	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	5.1E-6	0.00	0%		0.00	0%
Soil Ingestion	6.7E-4	0.65	43%	1.0E-3	0.98	53%
Inhalation	5.0E-8	0.00	0%		0.00	0%
Inhalation, bkgrnd		0.00	0%		0.00	0%
Water Ingestion		0.32	21%		0.32	17%
Food Ingestion, bkgrnd		0.54	36%		0.54	29%
Food Ingestion	0.0E+0	0.00	0%		0.00	0%

[Click here for REFERENCES](#)

CANCER RISKS VIA INGESTION OF SOIL
RECREATIONAL SCENARIO - ADULT

INPUT						Conversion Factors	
Recreational Scenario	Ingestion Rate (ING) (mg/day)	Exposure Frequency (EF) (days/year)	Exposure Duration (ED) (years)	Body Weight (BW) (kg)	Averaging Time (AT) (years)	Mass (MCF) (kg/mg)	Time (TCF) (days/year)
Average Exposure	100	20	24	52	70	1E-06	365

INPUT				OUTPUT	
Chemicals of Potential Concern (COPCs)	Concentrations (CS)		Toxicity Values		Average Exposure
	Site Concentrations (mg/kg)			Slope Factor (mg/kg-day) ⁻¹	Cancer Risk (CR)
RECREATIONAL SCENARIO					
Arsenic	14130			1.5	7.7E-05
RECREATIONAL SCENARIO CR SUBTOTAL					7.7E-05

Notes:

Enter "NA" for CS or toxicity values if they are not available

NA = not available

Average CS includes one-half the sample quantitation limit for COPCs that are undetected

mg day – milligrams per day

kg – kilograms

kg mg – kilograms per milligram

mg kg – milligrams per kilogram

mg kg-day – milligrams per kilogram per day

**CANCER RISKS VIA INHALATION OF DUST
RECREATIONAL SCENARIO - ADULT**

INPUT							Conversion Factors	
Recreational Scenario	Inhalation Rate (INH) (m ³ /day)	Particulate Concentration (PC) (mg/m ³)	Exposure Frequency (EF) (days/year)	Exposure Duration (ED) (years)	Body Weight (BW) (kg)	Averaging Time (AT) (years)	Mass (MCF) (kg/mg)	Time (TCF) (days/year)
Average Exposure	20	0.00076	20	24	52	70	1E-06	365

INPUT				OUTPUT	
Chemicals of Potential Concern (COPCs)	Concentrations (CS)		Toxicity Values		Average Exposure
	Site Concentrations (mg/kg)		Slope Factor (mg/kg-day) ⁻¹	Cancer Risk (CR)	
RECREATIONAL SCENARIO					
Arsenic	1413.0		15	7.8E-09	1.2E-07
RECREATIONAL SCENARIO CR SUBTOTAL					1.2E-07

Notes:

Enter "NA" for CS or toxicity values if they are not available

NA = not available

Average CS includes one-half the sample quantitation limit for COPCs that are undetected

Particulate concentration is equal to a particulate emission factor of 1.1E+9 m³/kg

m³/day = cubic meters per day

mg/m³ = milligrams per cubic meter

kg = kilograms

kg/mg = kilograms per milligram

mg/kg = milligrams per kilogram

mg/kg-day = milligrams per kilogram per day

**CANCER RISKS VIA DERMAL CONTACT WITH SOIL
RECREATIONAL SCENARIO - ADULT**

INPUT					
Recreational Scenario	Surface Area (SA) (cm ² -day)	Adherence Factor (AF) (mg/cm ²)	Exposure Frequency (EF) (days/year)	Exposure Duration (ED) (years)	Body Weight (BW) (kg)
Average Exposure	5,700	0.27	20	24	52
					70
					11-06
					365

INPUT						OUTPUT	
Chemicals of Potential Concern (COPCs)	Concentrations (CS)		Absorption Factor (ABS) (percent)	Toxicity Values		Average Exposure	
	Site Concentrations (mg/kg)			Slope Factor (mg/kg-day) ⁻¹	Cancer Risk (CR)		
RECREATION 4L SCENARIO							
Arsenic	14130		0.03	1.5	2.4E-05	3.5E-05	
RECREATION 4L SCENARIO CR SUBTOTAL						3.5E-05	

Notes

Enter "NA" for CS or toxicity values if they are not available

NA = not available

Average CS includes one-half the sample quantitation limit for COPCs that are undetected

cm²-day = square centimeters per day
 mg/cm² = milligrams per square centimeter
 kg = kilograms
 kg⁻¹ mg = kilograms per milligram
 mg/kg = milligrams per kilogram
 mg/kg-day = milligrams per kilogram per day

RECREATIONAL SCENARIO - ADULT
PATHWAY-SPECIFIC AND CHEMICAL-SPECIFIC CANCER RISK

INPUT				OUTPUT
Chemicals of Potential Concern	Cancer Risk - Recreational Scenario			<i>Chemical-Specific Cancer Risk</i>
	Ingestion of Soil	Inhalation of Dust	Dermal Contact with Soil	
	Exposure Risk	Exposure Risk	Exposure Risk	Total Exposure Risk
	7.7E-05	1.2E-07	3.5E-05	1.1E-04
Arsenic	7.7E-05	1.2E-07	3.5E-05	1.1E-04
<i>Pathway-Specific Cancer Risk:</i>				<i>Recreational Scenario Cumulative Cancer Risk</i>

HAZARD QUOTIENTS VIA INGESTION OF SOIL RECREATIONAL SCENARIO - ADULT

INPUT						
Recreational Scenario	Ingestion Rate (ING) (mg/day)	Exposure Frequency (EF) (days/year)	Exposure Duration (ED) (years)	Body Weight (BW) (kg)	Conversion Factors	
					Mass (MCF) (kg/mg)	Time (TCF) (days/year)
Average Exposure	100	20	24	52	1E-06	365

INPUT			OUTPUT	
Chemicals of Potential Concern (COPCs)	Concentrations (CS)	Toxicity Values Reference Dose (mg kg-day)	Average Exposure	
	Site Concentrations (mg kg)		ADD (mg kg-day)	Hazard Quotient (HQ)
RECREATIONAL SCENARIO				
Arsenic	1413.0	0.0003	1.5E-04	5.0E-01
RECREATIONAL SCENARIO HQ SUBTOTAL				5.0E-01

Notes:

Enter "NA" for CS or toxicity values if they are not available

NA = not available

Average CS includes one-half the sample quantitation limit for COPCs that are undetected

mg/day = milligrams per day

kg = kilograms

kg/mg = kilograms per milligram

mg/kg = milligrams per kilogram

mg/kg-day = milligrams per kilogram per day

HAZARD QUOTIENTS VIA INHALATION OF DUST RECREATIONAL SCENARIO - ADULT

INPUT							Conversion Factors	
Recreational Scenario	Inhalation Rate (INH) (m ³ /day)	Particulate Concentration (PC) (mg/m ³)	Exposure Frequency (EF) (days/year)	Exposure Duration (ED) (years)	Body Weight (BW) (kg)	Averaging Time (AT) (years)	Mass (MCF) (kg/mg)	Time (TCF) (days/year)
Average Exposure	20	0.00076	20	24	52	24	1E-06	365

INPUT			OUTPUT	
Chemicals of Potential Concern (COPC's)	Concentrations (C'S)	Toxicity Values Reference Dose (mg/kg-day)	Average Exposure	
	Site Concentrations (mg/kg)		ADD (mg/kgp-day)	Hazard Quotient (HQ)
RECREATIONAL SCENARIO				
Arsenic	1413.0	NA	2.3E-08	NA
RECREATIONAL SCENARIO HQ SUBTOTAL				
				NA

Notes:

Enter "NA" for CS or toxicity values if they are not available

NA = not available

Average CS includes one-half the sample quantitation limit for COPC's that are undetected

m³/day cubic meters per day
 mg/m³ milligrams per cubic meter
 kg kilograms
 kg/mg kilograms per milligram
 mg/kg milligrams per kilogram
 mg/kg-day milligrams per kilogram per day

HAZARD QUOTIENTS VIA DERMAL CONTACT WITH SOIL
RECREATIONAL SCENARIO - ADULT

INPUT						
Recreational Scenario	Surface Area (SA) (cm ² /day)	Adherence Factor (AF) (mg/cm ²)	Exposure Frequency (EF) (days/year)	Exposure Duration (ED) (years)	Body Weight (BW) (kg)	Averaging Time (AT) (years)
Average Exposure	5,700	0.27	20	24	52	24
						365

INPUT				OUTPUT		
Chemicals of Potential Concern (COPCs)	Concentrations (C/S)		Absorption Factor (ABS) (percent)	Toxicity Values Reference Dose (mg/kg-day)	Average Exposure	
	Site Concentrations (mg/kg)				ADD (mg/kg-day)	Hazard Quotient (HQ)
RECREATIONAL SCENARIO						
Arsenic	1413.0		0.03	0.0003	6.9E-05	2.3E-01
RECREATIONAL SCENARIO HQ SUBTOTAL					2.3E-01	

Notes:

Enter "NA" for C/S or toxicity values if they are not available

NA = not available

Average C/S includes one-half the sample quantitation limit for COPCs that are undetected

cm²/day = square centimeters per day
mg/cm² = milligrams per square centimeter
kg = kilograms
kg-mg = kilograms per milligram
mg/kg = milligrams per kilogram
mg/kg-day = milligrams per kilogram per day

RECREATIONAL SCENARIO - ADULT
PATHWAY-SPECIFIC AND CHEMICAL-SPECIFIC HAZARD INDICES

INPUT					OUTPUT
Chemicals of Potential Concern	Hazard Quotient - Recreational Scenario				<i>Chemical-Specific Hazard Index</i>
	Ingestion of Soil	Inhalation of Dust	Dermal Contact with Soil		
	Exposure Risk	Exposure Risk	Exposure Risk	Total Exposure Risk	
Arsenic	5.0E-01	0.0E+00	2.3E-01	7.3E-01	
<i>Pathway-Specific Hazard Index:</i>	5.0E-01	0.0E+00	2.3E-01	7.3E-01	
<i>Recreational Scenario Cumulative Hazard Index</i>					

CANCER RISKS VIA INGESTION OF SOIL
RECREATIONAL SCENARIO - CHILD

INPUT							Conversion Factors	
Recreational Scenario	Ingestion Rate (ING) (mg/day)	Exposure Frequency (EF) (days/year)	Exposure Duration (ED) (years)	Body Weight (BW) (kg)	Averaging Time (AT) (years)	Mass (MCF) (kg/mg)	Time (TCF) (days/year)	
Average Exposure	133	20	18	35	70	1E-06	365	

INPUT				OUTPUT	
Chemicals of Potential Concern (COPCs)	Concentrations (C'S)		Toxicity Values		Average Exposure
	Site Concentrations (mg/kg)		Slope Factor (mg/kg-day) ⁻¹	ADD (mg kg-day)	Cancer Risk (CR)
RECREATIONAL SCENARIO					
Arsenic	1413.0		1.5	7.6E-05	1.1E-04
RECREATIONAL SCENARIO CR SUBTOTAL					1.1E-04

Notes:

Enter "NA" for C'S or toxicity values if they are not available

NA = not available

Average C'S includes one-half the sample quantitation limit for COPCs that are undetected

mg day = milligrams per day

kg = kilograms

kg mg = kilograms per milligram

mg kg = milligrams per kilogram

mg kg-day = milligrams per kilogram per day

**CANCER RISKS VIA INHALATION OF DUST
RECREATIONAL SCENARIO - CHILD**

INPUT								
	Inhalation Rate (INH) (m ³ /day)	Particulate Concentration (PC) (mg/m ³)	Exposure Frequency (EF) (days/year)	Exposure Duration (ED) (years)	Body Weight (BW) (kg)	Averaging Time (AT) (years)	Conversion Factors	
							Mass (MCF) (kg/mg)	Time (TCF) (days/year)
Recreational Scenario								365
Average Exposure	4.8	0.00076	20	18	35	70	1E-06	

INPUT			OUTPUT		
Chemicals of Potential Concern (COPCs)	Concentrations (C'S)		Toxicity Values		Average Exposure
	Site Concentrations (mg/kg)		Slope Factor (mg/kg-day) ⁻¹	ADD (mg/kg-day)	Cancer Risk (C'R)
RECREATIONAL SCENARIO					
Arsenic	1413.0		15	2.1E-09	3.1E-08
RECREATIONAL SCENARIO CR SUBTOTAL					3.1E-08

Notes:

Enter "NA" for CS or toxicity values if they are not available

NA = not available

Average CS includes one-half the sample quantitation limit for COPCs that are undetected

Particulate concentration is equal to a particulate emission factor of 1.1E+9 m³/kg

m³/day = cubic meters per day
 mg/m³ = milligrams per cubic meter
 kg = kilograms
 kg/mg = kilograms per milligram
 mg/kg = milligrams per kilogram
 mg/kg-day = milligrams per kilogram per day

CANCER RISKS VIA DERMAL CONTACT WITH SOIL
RECREATIONAL SCENARIO - CHILD

INPUT						
Recreational Scenario	Surface Area (SA) (cm ² /day)	Adherence Factor (AF) (mg/cm ²)	Exposure Frequency (EF) (days/year)	Exposure Duration (ED) (years)	Body Weight (BW) (kg)	Averaging Time (AT) (years)
Average Exposure	3,700	0.20	20	18	35	70
						1E+06
						365

INPUT					OUTPUT		
Chemicals of Potential Concern (COPCs)	Concentrations (CS)		Absorption Factor (ABS) (percent)	Toxicity Values		Average Exposure	
	Site Concentrations (mg/kg)			Slope Factor (mg/kg-day) ⁻¹		ADD (mg/kg-day)	Cancer Risk (CR)
RECREATIONAL SCENARIO							
Arsenic	1413.0		0.03		1.5	1.3E-05	1.9E-05
RECREATIONAL SCENARIO CR SUBTOTAL							1.9E-05

Notes

Enter "NA" for CS or toxicity values if they are not available

NA = not available

Average CS includes one-half the sample quantitation limit for COPCs that are undetected

cm²/day = square centimeters per day
mg/cm² = milligrams per square centimeter
kg = kilograms
kg/mg = kilograms per milligram
mg/kg = milligrams per kilogram
mg/kg-day = milligrams per kilogram per day

**RECREATIONAL SCENARIO - CHILD
PATHWAY-SPECIFIC AND CHEMICAL-SPECIFIC CANCER RISK**

INPUT			OUTPUT
Chemicals of Potential Concern	Cancer Risk - Recreational Scenario		<i>Chemical-Specific Cancer Risk</i>
	Ingestion of Soil	Dermal Contact with Soil	
	Exposure Risk	Exposure Risk	
Arsenic	1.1E-04	3.1E-08	Total Exposure Risk 1.3E-04
<i>Pathway-Specific Cancer Risk:</i>	1.1E-04	3.1E-08	1.3E-04
			<i>Recreational Scenario Cumulative Cancer Risk</i>

HAZARD QUOTIENTS VIA INGESTION OF SOIL RECREATIONAL SCENARIO - CHILD

INPUT							
	Ingestion Rate (ING) (mg/day)	Exposure Frequency (F:F) (days/year)	Exposure Duration (E:D) (years)	Body Weight (BW) (kg)	Averaging Time (A:T) (years)	Conversion Factors	
						Mass (MCF) (kg/mg)	Time (TCF) (days/year)
Recreational Scenario							
Average Exposure	133	20	6	15	6	1E-06	365

INPUT			OUTPUT		
Chemicals of Potential Concern (COPCs)	Concentrations (CS)		Toxicity Values Reference Dose (mg/kg-day)	Average Exposure	
	Site Concentrations (mg/kg)			ADD (mg/kg-day)	Hazard Quotient (HQ)
RECREATIONAL SCENARIO					
Arsenic	1413.0		0.0003	6.9E-04	2.3E+00
RECREATIONAL SCENARIO HQ SUBTOTAL					2.3E+00

Notes:

Enter "NA" for CS or toxicity values if they are not available

NA -- not available

Average CS includes one-half the sample quantitation limit for COPC's that are undetected

mg day -- milligrams per day

kg -- kilograms

kg mg -- kilograms per milligram

mg/kg -- milligrams per kilogram

mg/kg-day -- milligrams per kilogram per day

HAZARD QUOTIENTS VIA INHALATION OF DUST RECREATIONAL SCENARIO - CHILD

INPUT								
Recreational Scenario	Inhalation Rate (INH) (m ³ /day)	Particulate Concentration (PC) (mg/m ³)	Exposure Frequency (EF) (days/year)	Exposure Duration (ED) (years)	Body Weight (BW) (kg)	Averaging Time (AT) (years)	Conversion Factors	
							Mass (MCF) (kg/mg)	Time (TCF) (days/year)
Average Exposure	4.8	0.00076	20	6	15	6	1E-06	365

Chemicals of Potential Concern (COPCs)	INPUT		Toxicity Values Reference Dose (mg/kg-day)	OUTPUT	
	Concentrations (CS)	Site Concentrations (mg/kg)		Average Exposure	Hazard Quotient (HQ)
RECREATIONAL SCENARIO					
Arsenic	1413.0		NA	1.9E-08	NA
RECREATIONAL SCENARIO HQ SUBTOTAL					
					NA

Notes:

Enter "NA" for CS or toxicity values if they are not available

NA – not available

Average CS includes one-half the sample quantitation limit for 'OPC's that are undetected

m³/day cubic meters per day
mg/m³ milligrams per cubic meter
kg kilograms
kg/mg kilograms per milligram
mg/kg milligrams per kilogram
mg·kg·day milligrams per kilogram

HAZARD QUOTIENTS VIA DERMAL CONTACT WITH SOIL RECREATIONAL SCENARIO - CHILD

INPUT								
Recreational Scenario	Surface Area (SA) (cm ² day)	Adherence Factor (AF) (mg/cm ²)	Exposure Frequency (EF) (days/year)	Exposure Duration (ED) (years)	Body Weight (BW) (kg)	Averaging Time (AT) (years)	Conversion Factors	
							Mass (MCF) (kg/mg)	Time (TCF) (days/year)
Average Exposure	2,800	0.20	20	6	15	6	11.06	365

INPUT			OUTPUT		
Chemicals of Potential Concern (COPCs)	Concentrations (CS)		Absorption Factor (ABS) (percent)	Toxicity Values Reference Dose (mg/kg-day)	Average Exposure
	Site Concentrations (mg/kg)				
RECREATIONAL SCENARIO					
Arsenic	1413.0		0.03	0.0003	2.9E-01
RECREATIONAL SCENARIO HQ SUBTOTAL					2.9E-01

Notes:

Enter "NA" for CS or toxicity values if they are not available

NA = not available

Average CS includes one half the sample quantitation limit for COPCs that are undetected

cm² day = square centimeters per day
 mg/cm² = milligrams per square centimeter
 kg = kilograms
 kg/mg = kilograms per milligram
 mg/kg = milligrams per kilogram
 mg/kg day = milligrams per kilogram per day

**RECREATIONAL SCENARIO - CHILD
PATHWAY-SPECIFIC AND CHEMICAL-SPECIFIC HAZARD INDICES**

INPUT				OUTPUT
Chemicals of Potential Concern	Hazard Quotient - Recreational Scenario			<i>Chemical-Specific Hazard Index</i>
	Ingestion of Soil	Inhalation of Dust	Dermal Contact with Soil	
	Exposure Risk	Exposure Risk	Exposure Risk	
	2.3E+00	0.0E+00	2.9E-01	
Arsenic				Total Exposure Risk 2.6E+00
<i>Pathway-Specific Hazard Index:</i>	2.3E+00	0.0E+00	2.9E-01	2.6E+00
<i>Recreational Scenario Cumulative Hazard Index</i>				

ECOLOGICAL RISK ASSESSMENT SPREADSHEET FOR ABANDONED MINE SITES

PAGE 1 - SITE SPECIFIC INFORMATION

SITE NAME: Spring Meadow Lake Site

	Aquatic Life Maximum Surface Water Conc ug/L	Assoc. Surface Water Hardness* mg/L	Maximum Sediment Conc. mg/Kg	Deer Ingestion Water Conc ug/L	Deer Ingestion Phytotoxicity Surface Conc mg/Kg	Contaminant of Concern ?
Arsenic	32.00	102	110	32	373	Y
Cadmium	0.00	400	0	0.00	0	N
Chromium III	0.0	400	0	0.0	0	N
Copper	0.0	400	0	0.0	0	N
Iron	0	400	0	0	0	N
Lead	3.0	102	319	3.0	519	Y
Mercury	0.00	400	0	0.00	0	N
Nickel	0.0	400	0	0.0	0	N
Silver	0.00	400	0	0.00	0	N
Zinc	10.0	102	619	10.0	1087	y

Note: Minimum hardness=25 mg/L; Maximum=400 mg/L
nhd = not hardness dependent CoCs

All site specific data are entered on page 1; pages 2 through 5 are lookup tables and page 6 presents the resultant EQs.

Enter media concentrations for the site, either areal averages or site maximum concentrations. If a contaminant does not meet the criteria for "contaminant of concern", enter 0 as the concentration or leave it blank (don't leave hardness blank). These criteria are listed below:

- 1) contaminants associated with and present at the site;
- 2) contaminants with concentrations significantly above background (generally 3 times higher);
- 3) contaminants with at least 20% of the measured concentrations above the detection limit; and,
- 4) contaminants with acceptable QA/QC results applied to the data

Column B are surface water concentrations for comparison to aquatic life standards. Enter the maximum concentration measured in "real" surface water at the site (i.e. not adit discharges or intermittent water) that aquatic life might live in.

Column C are hardness measurements for the corresponding surface water concentration in column B in mg/L. Note that the minimum hardness for AWQC calculation is 25 mg/L and the maximum is 400 mg/L. Don't leave blank.

Column D are the maximum sediment concentrations measured at the site in "real" surface water (not adit discharges or intermittent drainages) for aquatic life impacts.

Column E are surface water concentrations that deer might drink at the site. This includes adit discharges, intermittent drainages, and ponded water, as long as it is accessible by deer.

Column F are surface waste concentrations for both the deer ingestion (salt) scenario and the phytotoxicity scenario. Enter the mean surface concentration of the highest concentration source at the site (generally tailings).

ECOLOGICAL RISK ASSESSMENT SPREADSHEET FOR ABANDONED MINE SITES

PAGE 2 - AQUATIC LIFE CRITERIA EQ

SITE NAME: Spring Meadow Lake Site

	Acute Criteria ug/L	Chronic Criteria ug/L	Acute AWQC EQ	Chronic AWQC EQ
Arsenic	360	190	0.0889	0.1684
Cadmium	8.7	0.8	0.0000	0.0000
Chromium III	5612	268	0.0000	0.0000
Copper	65.4	38.7	0.0000	0.0000
Iron		1000	0.0000	0.0000
Lead	83.7	3.3	0.0358	0.9195
Mercury	2.4	0.012	0.0000	0.0000
Nickel	4582	509	0.0000	0.0000
Silver	44.0		0.0000	0.0000
Zinc	119	108	0.0840	0.0928
TOTAL			0.2088	1.1806

This page calculates AWQC for the hardness values supplied on page 1, column C. Both chronic and acute are calculated in the table; however, the chronic values are for reference only. Chronic criteria are not applicable unless surface water has been sampled over the entire range of hydrologic conditions at the site, and a statistically significant number of samples at each station are averaged to determine the chronic concentrations over time.

ECOLOGICAL RISK ASSESSMENT SPREADSHEET FOR ABANDONED MINE SITES

PAGE 3 - SEDIMENT QUALITY CRITERIA EQ

SITE NAME: Spring Meadow Lake Site

	SQC Effect Range- Medium* mg/Kg	Sediment EQ
Arsenic	85	1.2941
Cadmium	9	0.0000
Chromium III	145	0.0000
Copper	390	0.0000
Lead	110	2.9000
Nickel	50	0.0000
Zinc	270	2.2926
TOTAL		6.4867

* from Long and Morgan, 1991

ECOLOGICAL RISK ASSESSMENT SPREADSHEET FOR ABANDONED MINE SITES

PAGE 4 - DEER INGESTION EQ

SITE NAME: Spring Meadow Lake Site

	Deer Intake Dose Est. Soil + water mg/Kg-day	Deer Ingestion EQ	
Arsenic	0.0106	0.0017	Toxicological effects from ATSDR, 1991a
Cadmium	0.0000	0.0000	Toxicological effects from ATSDR, 1991b
Copper	0.0000	0.0000	Toxicological effects from NAS, 1980
Lead	0.0087	1.7387	Toxicological effects from ATSDR, 1991c
Zinc	0.0188	0.0000	Toxicological effects from Maita et al, 1981
TOTAL		1.7404	

ECOLOGICAL RISK ASSESSMENT SPREADSHEET FOR ABANDONED MINE SITES

PAGE 5 - PHYTOTOXICITY EQ

SITE NAME: Spring Meadow Lake Site

	Phytotoxic Soil Conc.* mg/Kg	Phytotoxicity EQ
Arsenic	50	7.4600
Cadmium	8	0.0000
Copper	125	0.0000
Lead	400	1.2975
Zinc	400	2.7175
TOTAL		11.4750

*Upper end of range, from Kabata-Pendias and Pendias, 1989

ECOLOGICAL RISK ASSESSMENT SPREADSHEET FOR ABANDONED MINE SITES

PAGE 6 - COMBINATION OF ECOLOGIC IMPACT QUOTIENTS (EQs)

SITE NAME: Spring Meadow Lake Site

	Aquatic Life- Surface Water EQ (Acute)	Aquatic Life- Sediment EQ	Deer Ingestion EQ	Plant Phytotoxicity EQ	Total by CoC
Arsenic	0.0889	1.2941	0.0017	7.4600	8.8447
Cadmium	0.0000	0.0000	0.0000	0.0000	0.0000
Chromium III	0.0000	0.0000			0.0000
Copper	0.0000	0.0000	0.0000	0.0000	0.0000
Iron	0.0000				0.0000
Lead	0.0358	2.9000	1.7387	1.2975	5.9720
Mercury	0.0000				0.0000
Nickel	0.0000	0.0000			0.0000
Silver	0.0000				0.0000
Zinc	0.0840	2.2926	0.0000	2.7175	5.0942
TOTAL	0.2088	6.4867	1.7404	11.4750	19.9108

6.0 EXPANDED ENGINEERING EVALUATION AND COST ANALYSIS

As requested by the Montana Department of Environmental Quality (DEQ) and the Mine Waste Cleanup Bureau (MWCB), Tetra Tech EM Inc. prepared an expanded engineering evaluation/cost analysis (EEE/CA) for the Spring Meadow Lake Site. The EEE/CA presents a detailed analysis of reclamation alternatives regulatory agencies can use for reclamation decision-making.

The reclamation process has been designed to be consistent with the requirements of the National Oil and Hazardous Substances Contingency Plan (NCP) as required by Montana's Abandoned Mined Land State Reclamation Plan (30 Code of Federal Regulations part 926) for sites where hazardous substances are, or may be, present. By following the NCP this reclamation process will also not be inconsistent with regulations for removal actions under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), and may comply with the Montana Comprehensive Environmental Cleanup and Responsibility Act (CECRA). Certain aspects of the process have been streamlined to meet the regulatory and functional needs of cleaning up relatively small abandoned mine sites. The reclamation alternatives considered for implementation at the Spring Meadow Lake Site include no action through complete reclamation activities. Reclamation alternatives presented in this EEE CA are applicable to the contaminated solid media only; no reclamation alternatives were developed for treatment of groundwater or surface water.

6.1 INTRODUCTION

The Spring Meadow Lake Site consists of portions of Spring Meadow Lake State Park and the Montana Department of Fish, Wildlife and Parks' (FWP) Montana Wildlife Center (see Figure 6-1). Spring Meadow Lake was formed by the excavation of sand and gravel by the former Helena Sand & Gravel Company. The lake consists of an oval-shaped main lake connected to a circular-shaped north arm and an irregularly shaped east arm.

The Montana Wildlife Center (2650 Euclid Avenue) is located on a flat lying lot overlooking the lake area. Buildings on the site were constructed in 1892 by the John Stedman Foundry and Machine Company, and housed those operations through 1901. The Western Improved Wire Fence Company of the United States of America next occupied the complex, but its tenure was short-lived and the site was abandoned in 1910. The Northwestern Metals Company acquired the site that year and installed a mill to process polymetallic ores using the Baker-Burwell chlorine leaching process.



- LEGEND**
- REMEDIAL INVESTIGATION SAMPLE LOCATIONS**
- ◆ MONITORING WELL LOCATION
 - SEDIMENT GRAB SAMPLE LOCATION
 - SURFACE WATER SAMPLE LOCATION
 - SURFACE WATER / SEDIMENT SAMPLE LOCATION
 - SURFACE SOIL SAMPLE LOCATION
 - BACKHOE TEST PIT SAMPLE LOCATION

- GENERAL FEATURES**
- BUILDING
 - ELEVATION CONTOUR MAJOR (5' INTERVAL)
 - - - ELEVATION CONTOUR MINOR (1' INTERVAL)
 - - - FENCE
 - - - PEDESTRIAN TRAIL
 - +++++ FORMER RAILROAD TRACK
 - TREE
 - - - MONTANA WILDLIFE CENTER PROPERTY LINE
 - - - SPRING MEADOW LAKE SITE PROPERTY LINE

- CONTAMINATED SOIL DEPTHS (IN FEET)**
- 0.5 SEDIMENT
 - 1
 - 2
 - 3
 - 4
 - 5
 - 15

NOTE

SOIL AREAS CONTAIN METALS OF CONCERN AT CONCENTRATIONS ABOVE RECREATIONAL OR WORKER ACTION LEVELS



Tt Tetra Tech EM Inc.
Spring Meadow Lake
Helena, Montana

FIGURE 6-1
SPRING MEADOW LAKE SITE
SOIL CONTAMINATION AREAS

100 0 100 200
SCALE IN FEET

This operation went into bankruptcy in 1915 and the property was taken over by the New York – Montana Testing and Engineering Company in 1916. This company handled testing and custom milling of gold-silver and manganese ores using various processes. It was also unsuccessful and closed in 1920. In the late 1920s, George F. Jacoby and his partner Thomas Brownlow acquired the site and the adjacent land and opened a gravel pit north of the old foundry/mill complex under the name Helena Sand and Gravel. This operation lasted until the late 1950s.

Subsequent use of the land has involved additional gravel pit operation, a construction business headquarters, and land speculation.

6.2 RECLAMATION OBJECTIVES AND GOALS

The overall objective of the Spring Meadow Lake Site reclamation project is to protect human health and the environment in accordance with the guidelines set forth by the NCP. Specifically, site reclamation must limit human and ecological exposure to mine-related contaminants and reduce the mobility of those contaminants through associated solid media and surface water exposure pathways.

A risk analysis was completed as part of the reclamation investigation (RI) discussed in Section 5. Arsenic and lead were present in elevated concentrations in some of the solid matrix samples and pose an unacceptable risk to human health and the environment. In addition, several surface water and groundwater samples also indicated elevated levels of arsenic above the human health standards.

There are currently no promulgated standards for metal concentrations in soil. The Montana DEQ has developed a conservative set of risk-based guidelines that are calculated for different contaminants using a recreational visitor exposure pathway scenario. The guidelines take into account the possibility of exposure through multiple exposure routes. Action levels for soils at Spring Meadow Lake Site have been determined based on risk assessment results generated during the RI. The soil recreational action levels for the metals of concern are listed in Table 5-17. The Montana DEQ also has surface water quality standards for aquatic life listed in Table 5-20.

6.3 SUMMARY OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Reclamation activities at the Spring Meadow Lake Site will incorporate federal and state cleanup requirements. The standards, requirements, criteria, or limitations that will be used to conduct reclamation activities for this site are commonly referred to as applicable or relevant and appropriate requirements (ARAR).

Two basic types of reclamation for abandoned mine sites are (1) on-site or off-site disposal (removal) with subsequent revegetation, and (2) in-place amelioration (reclamation) with subsequent revegetation. Removal is designed to eliminate a source of waste from a site and is often conducted to alleviate the most acute or toxic contaminated materials. Amelioration is designed to minimize, stabilize, or mitigate the contaminated materials to ensure a high level of contaminant reduction and to achieve successful reclamation at a site.

ARARs may be either “applicable” or “relevant and appropriate” to reclamation at a site, but not both. Applicable requirements are the standards, requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address hazardous substances, pollutants, contaminants, activities, locations, or other circumstances found at the site. The reclamation actions envisioned should satisfy all the jurisdictional prerequisites of a requirement to be applicable to the specific activity at a site.

Relevant and appropriate requirements are the standards, requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not applicable to hazardous substances, pollutants, contaminants, activities, locations, or other circumstances at a site, address problems or situations sufficiently similar to those encountered at a site that their use is well suited to a particular site. Factors that may be considered in making this determination, when the factors are pertinent, are presented in 40 Code of Federal Regulations (CFR) 300.400(g)(2). They include, among other considerations, examination of the purpose of the requirement and of the proposed activity, the medium and substances regulated by the requirement, the regulated actions or activities, and the potential use of resources affected by the requirement.

ARARs are divided into contaminant-specific, location-specific, and action-specific requirements. Contaminant-specific requirements govern the release of materials that possess certain chemical or physical characteristics or that contain specific chemical compounds to the environment. Contaminant-

specific ARARs generally set human or environmental risk-based criteria and protocol that, when applied to site-specific conditions, result in the establishment of numerical action values. These values establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment.

Location-specific ARARs relate to the geographic or physical position of the site, rather than to the nature of the contaminants. These ARARs restrict the concentration of hazardous substances or the conduct of cleanup because of their location in the environment.

Action-specific ARARs are usually technology- or activity-based requirements or are limitations on actions taken with respect to hazardous substances. A specific activity will trigger an action-specific ARAR. Unlike chemical-specific and location-specific ARARs, action-specific ARARs do not, in themselves, determine the reclamation alternative. Rather, action-specific ARARs indicate how the selected reclamation activity should be completed.

Nonpromulgated advisories or guidance documents issued by federal or state governments do not have the status of potential ARARs. However, these advisories and guidance are "to be considered" (TBC) when determining protective cleanup levels, as defined in 40 CFR 300.400 (g)(3). The TBC category consists of advisories, criteria, or guidance that were developed by the United States Environmental Protection Agency (EPA), other federal agencies, or states that may be useful in developing reclamation alternatives.

Only those state standards that are more stringent than any federal standard and that have been identified by the state are appropriately included as ARARs. Duplicative or less stringent standards will be deleted as appropriate when the final determination of ARARs is presented.

ARARs are defined as only federal environmental laws and state environmental or facility siting laws. The reclamation methods and operation and maintenance must, nevertheless, comply with all other applicable laws, both state and federal. Many such laws, while not strictly environmental or facility siting laws, have environmental impacts. Moreover, applicable laws that are not ARARs because they are not environmental or facility siting laws are not subject to the ARAR waiver provisions; instead, the applicable provisions of such laws must be observed. A separate list attached to the state ARARs is a noncomprehensive identification of other state law requirements that must be observed during reclamation, operation, and maintenance.

Appendices 6-A and 6-B provide descriptions of potential federal and state ARARs, respectively, and their applicability to the Spring Meadow Lake Site. In the event of any inconsistency between the law itself and the summaries in the appendixes, the ARAR is ultimately the requirement as set out in the law, rather than the paraphrased requirement provided in this document.

6.4 IDENTIFICATION AND SCREENING OF RESPONSE ACTIONS, TECHNOLOGY TYPES, AND PROCESS OPTIONS

The waste materials, or potential source materials, at the Spring Meadow Lake Site are located at areas within the approximately 20 acres of disturbed land. The four distinct waste types include subsurface soil contamination, surface soil contamination, submerged surface soil, and surface water contamination. The Spring Meadow Lake site is administratively divided into two distinct areas: (1) the Spring Meadow State Park; and (2) the Montana Wildlife Center. The developed Spring Meadow Lake State Park, including the east arm, is built around the former excavated sand and gravel pits. The Wildlife Center is developed on the original Stedman Foundry property that was used as a leaching mill, floatation mill for gold-silver and manganese ores, and for gravel mining operations. On this site, chain-link fenced pens and shelters for wildlife have been constructed. The buildings on site, the Stedman Foundry and the Machine Shop, have been placed on the National Register of Historic Places and are used by the Montana Wildlife Center as office and storage facilities. Future development of the area includes expansion of these divisions into other areas of the property. Therefore, any future development plans for both the State Park and Wildlife Center will also be addressed as the reclamation alternatives are developed. Any modifications or restrictions to future development in order to accommodate site reclamation will be noted for each alternative that is explored in more detail.

The selection of the appropriate reclamation alternative(s) for the Spring Meadow Lake Site will depend on the following: (1) the nature and types of waste materials; (2) the waste location; (3) the concentration of metals and other contaminants in the waste materials, (4) the volume of waste materials, and (5) the applicability of the reclamation alternatives. During the reclamation selection process, alternatives are developed and subjected to three phases of screening or evaluation. These phases included initial screening, alternative screening, and detailed analysis (EPA 1988). The results of the initial screening and alternative screening selection process for the Spring Meadow Lake Site are described in Sections 6.4 and 6.5. The detailed and comparative analysis of the reclamation alternatives is presented in Section 6.6, and Section 6.7 lists references.

6.4.1 Identification and Initial Screening of Reclamation Alternatives

The first step in the process for developing and analyzing reclamation alternatives for the Spring Meadow Lake Site is identifying and describing general response actions that may satisfy the reclamation objectives. General response actions are then progressively refined into technology types and process options. The process options are then screened and the retained technologies and process options are combined into potential media-specific reclamation alternatives.

After identifying the potential reclamation alternatives, the alternatives are subjected to initial screening, which is the first step in the alternative selection process. The purpose of the initial screening is to eliminate options that are not feasible from further consideration and retain those options that are potentially feasible. In addition, general response actions, technologies, and process options are evaluated for contaminated solid media only. For the Spring Meadow Lake Site, no technology evaluation has been conducted for surface water or groundwater. This decision was based primarily on the presumption that reclaiming the contaminated source materials will subsequently reduce any impacts to surface water and groundwater at the site. Separate, feasible reclamation alternatives may exist for each waste type and waste area found at the site.

General response actions, technologies, and process options potentially capable of meeting the reclamation objectives for the solid media at the Spring Meadow Lake Site are identified in Table 6-1. Response actions include no action, institutional controls, in place treatment, engineering controls, and excavation and treatment. The following paragraphs describe the results of the initial screening of the general response actions, technologies and process options for the Spring Meadow Lake Site.

6.4.1.1 No Action

Under the no action option, no reclamation actions would occur at the site. The no action response is a stand-alone response that is used as a baseline against which other reclamation alternatives are compared. The no action alternative will be retained through the detailed analysis of alternatives.

TABLE 6-1
GENERAL RESPONSE ACTIONS, TECHNOLOGY TYPES, AND PROCESS OPTIONS
SOLID MEDIA
SPRING MEADOW LAKE SITE

General Response Action	Technology Type	Process Options
No Action	None	None
Institutional Controls	Access Restrictions	Fencing/Barrier
Engineering Controls	Surface Controls	Consolidation
		Grading
		Revegetation/Erosion Protection
	Containment	Earthen Cover
		Earthen and Geomembrane Cap
	On-Site Disposal	Earthen Cover
		Earthen and Geomembrane Cap
		Modified RCRA Subtitle C Repository
		RCRA Subtitle C Repository
	Off-Site Disposal	Solid Waste Landfill
Excavation and Treatment	Fixation/Stabilization	Cement/Silicates
	Reprocessing	Milling/Smelting
	Physical/Chemical Treatment	Soil Washing
		Acid Extraction
		Alkaline Leaching
	Thermal Treatment	Rotary Kiln
		Vitrification
In-Place Treatment	Physical/Chemical Treatment	Soil Flushing
		Stabilization
		Dewatering
	Thermal Treatment	Vitrification

6.4.1.2 Institutional Controls

Institutional controls can be used to protect human health and the environment by precluding future access to, or development of, affected areas. In addition, these restrictions may be used to protect an implemented remedy. Potentially applicable institutional controls consist of access restrictions or land use controls. Access restrictions typically include physical barriers, such as fencing, that could prevent both human and wildlife access to the site to preclude exposure to site contamination and to protect the integrity of the remedy. Land use controls would restrict the use of the land, or specific areas, to prevent unacceptable risks to human or wildlife exposure. This may influence the future site development goals or objectives depending upon the alternatives employed.

Institutional controls are not considered feasible as a stand-alone remedy; however they could be implemented in combination with other alternatives. The site owner and managing agency, Montana Department of Fish Wildlife and Parks, with possible input from local government, would likely be responsible for enforcing any institutional controls developed as part of an alternative for the Spring Meadow Lake Site. Therefore, these entities must be involved in developing and eventually implementing any institutional controls.

These types of institutional controls do not, by themselves, achieve a specific cleanup goal. Considering the baseline risks posed by contaminants at the site, institutional controls alone are not considered adequate to mitigate these potential human health and ecological risks. However, institutional controls will be considered in conjunction with other reclamation alternatives in this evaluation.

6.4.1.3 Engineering Controls

Engineering controls are used primarily to reduce the mobility of, and exposure to, contaminants. These goals are accomplished by creating a barrier that prevents direct exposure and transport of waste from the contaminated source to the surrounding media. Engineering controls do not reduce the volume or toxicity of the hazardous material. Engineering controls typically applied include containment capping, revegetation, runoff control, and disposal in a repository. These engineering controls are discussed in the following subsections.

Surface Controls

Surface control measures are used primarily to reduce contaminant mobility and limit direct exposure. Surface controls may be appropriate in more remote areas where direct human contact is not a primary concern (in other words, where human receptors are not living or working directly on or near the site). Surface control process options include consolidation, grading, revegetating, and erosion protection. These process options are usually integrated as a single reclamation alternative.

Consolidation involves grouping similar waste types in a common area for subsequent management or treatment. Excavation during consolidation is accomplished with standard earthmoving equipment, including scrapers, bulldozers, excavators, loaders, and trucks. Consolidation is especially applicable when multiple waste sources are present at a site and one or more of the sources requires removal from particularly sensitive areas (that is, floodplain or heavy traffic). It also may be especially applicable when one large combined waste source is treated in a particular location, rather than several smaller waste sources dispersed throughout an area. Precautionary measures, such as temporary stream diversion or isolation, would be necessary for excavating materials contained in the small drainages at the site. Containment and treatment of water encountered during excavation may also be necessary.

Grading is the general term for techniques used to reshape the ground surface to reduce slopes, manage surface water infiltration and runoff, and aid in erosion control. The spreading and compaction steps used in grading are routine construction practices. The equipment and methods used in grading are similar for all surfaces, but will vary slightly depending on the waste location and the surrounding terrain. Equipment may include bulldozers, scrapers, graders, and compactors. Periodic maintenance and regrading may be necessary to eliminate depressions formed as a result of settlement, subsidence, or erosion.

Revegetation involves adding soil amendments to the waste surface to provide nutrients, organic material, and neutralizing agents and improve the water storage capacity of the contaminated media, as necessary. Revegetation will provide an erosion-resistant cover that protects the ground surface from surface water and wind erosion and reduces net infiltration through the contaminated medium by increasing evapotranspiration processes. Revegetation can also reduce the potential for direct contact. In general, revegetation includes the following steps: (1) selecting appropriate plant species, (2) preparing the seed bed, which may include deep application of soil amendments to provide acid buffering and enhance vegetation, as necessary, (3) seeding and planting, and (4) mulching and chemical fertilizing.

Erosion protection includes using erosion-resistant materials, such as mulch, natural or synthetic fabric mats, riprap, and surface water diversion ditches to reduce the erosion potential at the surface of the contaminated medium. The erosion-resistant materials are placed in areas susceptible to surface water erosion (concentrated flow or overland flow) or wind erosion. Proper erosion protection design requires knowledge of the characteristics of the drainage area, average slopes, soil texture, vegetation types and abundance, and precipitation data.

Surface controls are considered a feasible option for solid media at the Spring Meadow Lake Site and will be retained for further consideration as a reclamation alternative, or in conjunction with other alternatives.

Containment

A containment approach leaves waste materials in place and uses capping to reduce or eliminate exposure to, and mobility of, contaminated medium. Containment source control measures can be used to divert surface water from the contaminated medium and to minimize infiltration (and subsequent formation of leachate) of surface water and precipitation into the underlying contaminated medium. Infiltration can be reduced or prevented by physical barriers or by increasing evapotranspiration processes. The physical capping or covering of wastes during containment reduces or eliminates the potential health risk that may be associated with exposure (direct contact or airborne releases of particulates) to the contaminated media.

The design of the cap or cover may vary in complexity from a simple earthen cover to a multilayered cap designed to meet Resource Conservation and Recovery Act (RCRA) requirements. Factors to consider in design of the cap or cover include physical conditions of the contaminated media, leachability, site hydrogeology, precipitation, depth to groundwater, current groundwater quality, area groundwater use, and applicable groundwater standards. Stringent performance standards may not always be appropriate for the cap, particularly where the toxicity of the contaminated medium is relatively low, where the cap is intended to be temporary, where there is low precipitation, or where the waste is not leached by infiltrating rain water. Specific cap design should also consider the desired land use after construction.

Containment is considered a standard construction practice. Equipment and construction methods associated with containment are readily available, and design methods and requirements are well understood.

Containment is considered a feasible option for solid media at the Spring Meadow Lake Site and will be retained for further consideration as a reclamation alternative or in combination with other alternatives.

On-Site Disposal

Permanent, on-site disposal is used as a source control measure and is similar to containment. The objectives of on-site disposal are the same as for containment, except that disposal includes excavation and consolidation of waste into a single, usually smaller area, and may involve installing physical barriers beneath as well as above the waste. This added barrier may be needed to provide additional protection of groundwater from potential leachate contamination.

On-site disposal options may be applied to treated or untreated contaminated materials. Treatment may become a cost-effective option as materials are excavated and moved during this process. The design configuration of an on-site repository would depend on the toxicity and type of material that requires disposal. The design could range in complexity from an earthen cover, an earthen cap with geomembrane liner, a modified RCRA Subtitle C repository, or a RCRA Subtitle C repository.

Factors to consider in design include the physical condition of the contaminated media, leachability, site hydrogeology, precipitation, depth to groundwater, current groundwater quality, area groundwater use, and applicable groundwater standards. Stringent performance standards may not always be appropriate for the repository, particularly where the toxicity of the contaminated medium is relatively low, where there is very low precipitation, or where the waste is not leached by infiltrating rain water. Desired land use after construction should also be considered in design of the repository.

Containment of water encountered drying excavated materials and during excavating may also be necessary due to the shallow groundwater at the site and the limited removal of submerged soils. Small equipment to minimize the mixing or to assist in drying of wet material may also be necessary.

A potential on-site repository area has been identified during the reclamation investigation and is shown on Figure 6-1. Therefore, on-site disposal options will be retained for further evaluation.

Off-Site Disposal

Off-site disposal involves placing excavated contaminated material in an engineered containment facility located outside the boundary of the site. Off-site disposal options may be applied to pretreated or untreated contaminated materials. Any non-Bevill exempt materials that fail to meet the Toxicity Characteristic Leaching Procedure (TCLP) criteria, if disposed of off site, would require disposal in a RCRA-permitted treatment, storage, and disposal (TSD) facility. Conversely, Bevill exempt mine waste derived from the beneficiation and extraction of ores could be disposed of in an off-site mine waste repository or disposed of as solid waste in a permitted sanitary landfill in compliance with other applicable laws.

The closest RCRA hazardous waste landfill locations are in Utah, Idaho, and Oregon. Excavation and disposal at an off-site RCRA hazardous waste landfill is considered too costly as an alternative for all mine wastes at the Spring Meadow Lake Site. Off-site disposal in a RCRA hazardous waste landfill will be retained only for mill wastes that may not be Bevill exempt; however, no non-exempt waste has been identified at the site.

Disposal of wastes at the closed Basin Creek Mine located 20 miles south of the Spring Meadow Lake Site will be considered as part of this EEE/CA. Off-site relocation at the Basin Creek Mine would involve placement of Spring Meadow wastes onto Leach Pad 1 (LP1) along with other relocated mine waste prior to the final capping of Leach Pad 1. Relocation of Spring Meadow wastes with other mine waste at LP1 would coincide with ongoing mine reclamation projects.

Disposal of wastes in an off-site landfill will be considered as part of this EEE/CA. Two options are available locally; disposal at the city of Helena Landfill, and disposal at the Valley View landfill in East Helena. Each landfill is located approximately 20 miles from the Spring Meadow Lake site. The landfills would only be authorized to accept waste not classified as hazardous. As no hazardous waste has been identified on the site, this remains a viable alternative.

6.4.1.4 Excavation and Treatment

Excavation and treatment incorporate the removal of contaminated media and subsequent treatment via a specific treatment process that chemically, physically, or thermally results in a reduction in the toxicity and volume of the contaminant. Treatment processes have the primary objective of either: (1)

concentrating the metal contaminants for additional treatment or recovery of valuable constituents, or (2) reducing the toxicity of the hazardous constituents.

Excavation can be completed using conventional earth-moving equipment and accepted hazardous materials handling procedures. Precautionary measures, such as stream diversion or isolation, would be necessary for excavating materials contained in the small drainages on the site. Containment and treatment of water encountered during excavation may also be necessary.

Fixation and Stabilization

Fixation and stabilization technologies are used to treat materials by physically encapsulating them in an inert matrix (stabilization) and chemically altering them to reduce the mobility and toxicity of their constituents (fixation). These technologies generally involve mixing materials with binding agents under prescribed conditions to form a stable matrix. Fixation and stabilization are established technologies for treating inorganic contaminants. The technologies incorporate a reagent or combination of reagents to facilitate a chemical and physical reduction of the mobility of contaminants in the solid media. Lime/fly ash-based treatment processes and pozzolan/cement-based treatment processes are potentially applicable fixation and stabilization technologies.

Excavation and subsequent fixation and stabilization treatment are not considered feasible options for the Spring Meadow Lake Site because the large volume of waste makes the treatment cost prohibitive. Other feasible options can provide equal protectiveness.

Reprocessing

Reprocessing involves excavating and transporting the waste materials to an existing permitted mill or smelter facility for processing and economic recovery of target metals. Applicability of this option depends on market prices of the target metals and the willingness of an existing permitted facility to accept and process the material and dispose of the waste. Although metals have been reprocessed at active facilities in the past, permit limitations, CERCLA liability, and process constraints all limit the feasibility of this process option.

At this time, reprocessing is not considered feasible for the material at this site based on the lack of an available reprocessing facility and the expected high cost of transportation and reprocessing.

Reprocessing could become feasible in the future, however, depending on market conditions and the availability of a suitable reprocessing facility. This process is not being carried forward for detailed analysis since other options can provide equal protectiveness.

Physical and Chemical Treatment

Physical treatment processes concentrate constituents into a relatively small volume for disposal or further treatment. Chemical treatment processes act through the addition of a chemical reagent that removes or fixates the contaminants. The net result of chemical treatment processes is a reduction of toxicity and mobility of contaminants in the solid media. Chemical treatment processes often work in conjunction with physical processes to wash the contaminated media with water, acids, bases, or surfactant. Potentially applicable physical and chemical treatment process options include soil washing, acid extraction, and alkaline leaching.

Soil washing is an innovative treatment process that consists of washing the contaminated medium with water in a heap, vat, or agitated vessel to dissolve water-soluble contaminants. Soil washing requires that contaminants be readily soluble in water and sized sufficiently small so that dissolution can be achieved in a practical retention time. Dissolved metal constituents contained in the wash solution are precipitated as insoluble compounds, and the treated solids are dewatered before additional treatment or disposal. The precipitates form a sludge that would require additional treatment, such as dewatering or stabilization, before disposal.

Acid extraction applies an acidic solution to the contaminated medium in a heap, vat, or agitated vessel. Depending on temperature, pressure, and acid concentration, varying quantities of the metal constituents in the contaminated medium would be solubilized. A broader range of contaminants can be expected to be acid soluble at ambient conditions using acid extraction versus soil washing; however, sulfide compounds may be acid soluble only under extreme conditions of temperature and pressure. Dissolved contaminants are subsequently precipitated for additional treatment and disposal.

Alkaline leaching is similar to acid extraction in that a leaching solution (in this case, ammonia, lime, or caustic soda) is applied to the contaminated medium in a heap, vat, or agitated vessel. Alkaline leaching is potentially effective for leaching most metals from the contaminated media; however, removal of arsenic is not well documented.

Excavation and subsequent physical and chemical treatment are not considered feasible options because the large volume of waste makes treatment cost prohibitive. Other feasible options can provide equal protectiveness.

Thermal Treatment

Under thermal treatment technologies, heat is applied to the contaminated medium to volatilize and oxidize metals and render them amenable to additional processing and to vitrify the contaminated medium into a glass-like, nontoxic, nonleachable matrix. Potentially applicable moderate-temperature thermal processes, which volatilize metals and form metallic oxide particulates, include the fluidized bed reactor, the rotary kiln, and the multihearth kiln. Potentially applicable high-temperature thermal treatment processes include high-temperature vitrification, which melts and volatilizes all components of the contaminated medium. Volatile contaminants and gaseous oxides of sulfur are driven off as gases in the process, and the nonvolatile, molten material that contains contaminants is cooled and, in the process, vitrified.

Thermal treatment technologies can be applied to a wet or dry contaminated medium; however, the effectiveness may vary somewhat with variable moisture content and particle size. Crushing may be necessary as a pretreatment step, especially for large and variable particle sizes, such as the materials in waste rock dumps. Moderate-temperature thermal processes should be considered only as pretreatment for other treatment options. This process concentrates the contaminants into a highly mobile (and potentially more toxic) form. High-temperature thermal processes immobilize most metal contaminants into a vitrified slag that would require proper disposal. The volatile metals would be removed or concentrated into particulate metal oxides, which would likely require disposal as hazardous waste. Thermal treatment costs are extremely high compared with other potentially applicable reclamation technologies.

Excavation and subsequent thermal treatment are not considered feasible options because the large volume of waste makes treatment cost prohibitive. Other feasible options can provide equal protectiveness.

6.4.1.5 In-Place Treatment

In-place treatment involves treating the contaminated medium where it is currently located. In-place technologies reduce the mobility and toxicity of the contaminated medium and may reduce worker exposure to the contaminated materials; however, they allow a lesser degree of control, in general, than do ex situ treatment options.

Physical and Chemical Treatment

Potentially applicable in-place physical and chemical treatment technologies include stabilization and solidification, soil flushing, and dewatering.

In-place stabilization and solidification are similar to conventional stabilization in that a solidifying agent (or combination of agents) is used to create a chemical or physical change in the mobility and toxicity of the contaminants. The in-place process uses deep-mixing techniques to allow maximum contact of the solidifying agents with the contaminated medium.

Soil flushing is an innovative process that injects an acidic or basic reagent or chelating agent into the contaminated medium to solubilize metals. The solubilized metals are extracted using established dewatering techniques, and the extracted solution is then treated to recover metals or is disposed of as aqueous waste. Low-permeability materials may hinder proper circulation, flushing solution reaction, and ultimate recovery of the solution. Currently, soil flushing has been demonstrated only at the pilot scale.

Dewatering is a common pretreatment process used to extract water from a contaminated solid medium. Common dewatering options include well-field extraction, extraction trenches, surface water diversion, and gravity draining of stockpiled saturated materials. Dewatering is most effective in conjunction with additional reclamation technologies that reduce contaminant toxicity, mobility, or volume.

In-place physical and chemical treatment is not considered a feasible option because the large volume of waste at the site makes the treatment cost prohibitive. Other feasible options can provide equal or greater protectiveness.

Thermal Treatment

In-place vitrification is an innovative process used to melt contaminated solid media in place to immobilize metals into a glass-like, inert, nonleachable solid matrix. Vitrification requires significant energy to generate sufficient current to force the solid medium to act as a continuous electrical conductor. This technology is seriously inhibited by high moisture content. Furthermore, gases generated by the process must be collected and treated in an off-gas treatment system. In-place vitrification has been demonstrated only at the pilot scale, and treatment costs are extremely high compared with other treatment technologies.

In-place thermal treatment is not considered a feasible option because the large volume of waste at the site makes the treatment cost prohibitive. Other feasible options can provide equal or greater protectiveness.

6.4.2 Screening Summary and Identification of Reclamation Alternatives

A summary of the initial screening of reclamation response actions, technologies, and process options is provided in Table 6-2. The next step in the evaluation and selection process for a reclamation alternative is alternative screening. The alternative screening compares the options identified based on the NCP criteria of effectiveness, implementability, and relative costs, and eliminates alternatives to reduce the number carried forward for detailed analysis. Alternatives can be eliminated from further consideration if they do not meet the criteria of effectiveness or implementability. A second screening can be utilized if an alternative can be eliminated due to the cost being substantially higher than other alternatives and at least one other alternative is retained that offers equal protectiveness. This second level of alternative screening is effective as a method of reducing the number of options that will require a subsequent detailed analysis. This second level of screening will not be utilized because the number of alternatives is reasonable for a detailed analysis.

The reclamation response actions, technologies, and process options that were retained have been combined into the reclamation alternatives shown in Table 6-3. Five feasible reclamation alternatives were identified. All of these alternatives will be carried through to the detailed analysis.

TABLE 6-2

RECLAMATION TECHNOLOGY SCREENING COMMENTS SUMMARY
SOLID MEDIA
SPRING MEADOW LAKE SITE

General Response Actions	Reclamation Technology	Process Options	Description	Screening Comment
NO ACTION INSTITUTIONAL CONTROLS	None	Not applicable	No action	Retained for baseline comparison
	Access Restrictions	Fencing Barrier	Install fences around waste areas to limit access	Not applicable as fencing would interfere with recreational uses of the site.
		Land Use Control	Implement restrictions to control current and future land use	Potentially effective in conjunction with other technologies; readily implementable
ENGINEERING CONTROLS	Surface Controls	Consolidation, Grading, Revegetation, Erosion Protection	Combine similar waste types in a common area; level out waste piles to reduce slopes for managing surface water infiltration, runoff, and erosion; add amendments to waste and seed with appropriate vegetative species to establish an erosion-resistant ground surface	Effectiveness is questionable since waste contains high concentrations of phytotoxic chemicals; limits direct exposure; readily implementable
		Earthen Cover	Apply soil and establish vegetative cover to stabilize surface; waste materials are left in place	Surface infiltration and runoff potential would be reduced, but not prevented; limits direct exposure; readily implementable
	On-Site Disposal	Earthen and Geomembrane Cap	Install geomembrane with soil vegetation over surface; waste materials are left in place	Surface infiltration and runoff potential would be significantly reduced, or eliminated; limits direct exposure; readily implementable
		Earthen Cover	Excavate waste materials and deposit on site in a constructed repository with an earthen cover	Surface infiltration and runoff potential would be reduced, but not prevented; limits direct exposure; readily implementable
		Earthen Cap and Geomembrane Liner	Excavate waste materials and deposit on site in a constructed repository with an earthen and geomembrane cap	Surface infiltration and runoff potential would be significantly reduced, or eliminated; limits direct exposure; readily implementable
		Modified RCRA Subtitle C Repository	Excavate waste materials and deposit on site in a constructed Modified RCRA Subtitle C Repository	Surface infiltration and runoff potential would be significantly reduced, or eliminated; limits direct exposure; readily implementable

TABLE 6-2 (Continued)

RECLAMATION TECHNOLOGY SCREENING COMMENTS SUMMARY
SOLID MEDIA
SPRING MEADOW LAKE SITE

General Response Actions	Reclamation Technology	Process Options	Description	Screening Comment
ENGINEERING CONTROLS (Continued)	On-Site Disposal	RCRA Subtitle C Repository	Excavate waste materials and deposit on site in a constructed RCRA Subtitle C Repository	Potentially effective for all Bevill-exempt wastes; more costly and potentially more effective than Modified RCRA repository but added protection not considered necessary at this site
	Off-Site Disposal	Solid Waste Landfill	Excavate and dispose of nonhazardous solid wastes permanently in a non-RCRA facility	Potentially effective for nonhazardous materials or nonhazardous residues from other treatment process options; readily implementable
		Relocation with other Mine Wastes	Excavate waste materials, relocate, and consolidate with other mine wastes in Leach Pad 1 at the closed Basin Creek Mine	Surface infiltration and runoff potential would be effectively eliminated; limits direct exposure; readily implementable
EXCAVATION AND TREATMENT	Fixation/Stabilization	RCRA Subtitle C Landfill	Excavate and dispose of wastes permanently in a RCRA-permitted facility	Potentially effective, and readily implementable; but cost prohibitive and no hazardous waste identified at the site
		Cement/Silicates	Incorporate hazardous constituents into non-leachable cement or pozzolan solidifying agents	Extensive treatability testing required; proper disposal of stabilized product would be required; potentially implementable, but cost-prohibitive
	Reprocessing	Milling/Smelter	Ship wastes to existing milling/smelter facility for economic extraction of metals	Potentially effective but a facility is not located in the area
	Physical/Chemical Treatment	Soil Washing	Separate hazardous constituents from solid media via dissolution and subsequent precipitation	Effectiveness is questionable; potential exists to increase mobility by providing partial dissolution of contaminants; more difficulty encountered with wider range of contaminants
		Acid Extraction	Mobilize hazardous constituents via acid leaching and recover by subsequent precipitation	Effectiveness is questionable; sulfides would be acid soluble only under extreme conditions of temperature and pressure
		Alkaline Leaching	Use alkaline solution to leach contaminants from solid media in a heap, vat, or agitated vessel	Effectiveness is not well documented for arsenic

TABLE 6-2 (Continued)

RECLAMATION TECHNOLOGY SCREENING COMMENTS SUMMARY
SOLID MEDIA
SPRING MEADOW LAKE SITE

General Response Actions	Reclamation Technology	Process Options	Description	Screening Comment
EXCAVATION AND TREATMENT (Continued)	Thermal Treatment	Fluidized Bed Reactor/Rotary Kiln/Multihearth Kiln	Concentrate hazardous constituents into a small volume by volatilization of metals and formation of metallic oxides as particulates	Further treatment is required to treat process by-products; potentially implementable, but cost prohibitive
		Vitrification	Use extremely high temperature to melt and/or volatilize all components of the solid media; the molten material is cooled and, in the process, vitrified into a nonleachable form	Further treatment is required to treat process by-products; potentially implementable, but cost prohibitive
IN-PLACE TREATMENT	Physical/Chemical Treatment	Stabilization	Stabilize waste constituents in place when combined with injected stabilizing agents	Extensive treatability testing required; potentially implementable, but cost prohibitive
		Solidification	Use solidifying agents in conjunction with deep soil mixing techniques to facilitate a physical or chemical change in mobility of the contaminants	Extensive treatability testing required; potentially implementable, but cost prohibitive
		Soil Flushing	Acid base reagent or chelating agent injected into solid media to solubilize metals; solubilized reagents are subsequently extracted using dewatering techniques	Effectiveness not certain; innovative process currently in its pilot stage
	Thermal Treatment	Vitrification	Subject contaminated solid media to extremely high temperature in place; during cooling, material is vitrified into non-leachable form	Difficulties may be encountered in establishing adequate control; potentially implementable, but cost prohibitive

Note. Eliminated alternatives are shaded.

TABLE 6-3
RECLAMATION ALTERNATIVE INITIAL SCREENING SUMMARY
SOLID MEDIA
SPRING MEADOW LAKE SITE

Waste Type	Alternative Number	Alternative Description
Site-Wide Waste Mineral Processing Waste and Soils	Alternative 1	No Action
	Alternative 2	Institutional Controls
	Alternative 3	Containment (with earthen and geomembrane cap)
	Alternative 4	Excavation and On-Site Disposal in Repository (geomembrane bottom liner and earthen and geomembrane cap)
	Alternative 5	Excavation and relocation at Basin Creek Mine Leach Pad 1
	Alternative 6	Excavation and Off-site Disposal at a Solid Waste Landfill

6.5 DETAILED ANALYSIS OF RECLAMATION ALTERNATIVES

The third step in the selection process for reclamation alternatives for the Spring Meadow Lake site is the detailed analysis. The purpose of the detailed analysis is to evaluate the screened reclamation alternatives for their effectiveness, implementability, and cost in order to control and reduce toxicity, mobility, and volume of wastes at the Spring Meadow Lake site.

As required by CERCLA and the NCP, reclamation alternatives that were retained after the initial and alternative screening selection processes were evaluated individually against the following criteria:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness
- Implementability
- Cost

Acceptance by the supporting agencies and community are additional criteria that will be addressed after MWCB and the public review the alternative evaluations presented. These analysis criteria have been used to address the CERCLA requirements and considerations with EPA guidance (1988), as well as

additional technical and policy considerations. The criteria also serve as the basis for conducting the detailed analysis and subsequently selecting the preferred reclamation alternative.

The criteria listed above are categorized into three groups, each with distinct functions in selecting the preferred alternative. These groups include:

- **Threshold Criteria** — overall protection of human health and the environment and compliance with ARARs.
- **Primary Balancing Criteria** — long-term effectiveness and permanence; reduction of toxicity, mobility or volume through treatment; short-term effectiveness, implementability, and cost.
- **Modifying Criteria** — state and community acceptance.

Overall protection of human health and the environment and compliance with ARARs are threshold criteria that must be satisfied for an alternative to be eligible for selection. Long-term effectiveness and permanence; reduction of toxicity, mobility, or volume; short-term effectiveness; implementability; and cost are the primary balancing criteria used to weigh major trade-offs among alternative hazardous waste management strategies. State and community acceptance are modifying criteria that are formally considered after public comment is received on the proposed reclamation approach and the EEE CA report. Each criterion is presented and described further in Table 6-4.

The final step of this analysis is a comparative analysis of the alternatives. The analysis will discuss each alternative's relative strengths and weaknesses with respect to each of the criteria, and how reasonably key uncertainties could change expectations of the relative performance. Once completed, this evaluation will be used to select the preferred alternatives. The selection will be documented in a decision document. Public meetings to present the alternatives will be conducted, and significant oral and written comments will be addressed in writing.

The reclamation alternatives that were retained after the initial and alternative screening selection processes are included in the detailed analysis. Each reclamation alternative under consideration for use at the Spring Meadow Lake site is classified as an interim or removal action, and is not considered a complete reclamation action. In addition, the reclamation alternatives are applicable to the solid media only; no reclamation alternatives were developed for treatment of groundwater or surface water.

TABLE 6-4
ANALYSIS OF SCREENED RECLAMATION ACTIVITIES
SOLID MEDIA
SPRING MEADOW LAKE SITE

THRESHOLD CRITERIA				
Overall Protection of Human Health and the Environment		Compliance with ARARs		
How alternative provides human health and environmental protection	- Compliance with chemical-specific ARARs - Compliance with action-specific ARARs - Compliance with location-specific ARARs - Compliance with other criteria, advisories, and guidance (IBC's)			
PRIMARY BALANCING CRITERIA				
Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume Through Treatment	Short-Term Effectiveness	Implementability	Cost
- Magnitude of residual risk - Adequacy and reliability of controls	- Treatment process used and materials treated - Amount of hazardous materials destroyed or treated - Degree of expected reductions in toxicity, mobility, and volume - Degree to which treatment is irreversible - Type and quantity of residuals remaining after treatment	- Protection of community during removal actions - Protection of workers during removal actions - Environmental impacts - Time until removal action objectives are achieved	- Ability to construct and operate the technology - Reliability of the treatment - Pace of undertaking additional removal actions, if necessary - Ability to obtain approvals from other agencies - Coordination with other agencies - Availability of off-site treatment, storage, and disposal services and capability - Availability of necessary equipment and specialists - Availability of prospective technologies	- Capital costs - Operating and maintenance costs - Present worth cost

TABLE 6-4 (Continued)

ANALYSIS OF SCREENED RECLAMATION ACTIVITIES
SOLID MEDIA
SPRING MEADOW LAKE SITE

MODIFYING CRITERIA	
Supporting Agency Acceptance ^a	Community Acceptance ^a
• Features of the alternative the supporting agencies support • Features of the alternative about which the supporting agencies have reservations • Elements of the alternative the supporting agencies strongly oppose	• Features of the alternative the community supports • Features of the alternative about which the community has reservations • Elements of the alternative the community strongly opposes

Note:

- ^a These criteria are being assessed primarily following public comment on the RI report and the expanded engineering evaluation cost analysis.

The rationale for not directly developing alternatives for these media was based on the presumption that remediating the solid media will subsequently reduce or eliminate the potential impacts to groundwater and surface water.

6.5.1 Evaluation of Threshold Criteria

Each reclamation alternative was assessed for overall risk reduction and evaluated for compliance with ARARs in the following detailed evaluations of the threshold criteria. The exposure pathways of concern (ingestion, inhalation, and dermal) that were identified in the risk assessment were qualitatively and quantitatively evaluated to identify the risk reduction required to achieve the desired residual risk level (HQ less than 1 or risk less than 1.0×10^{-4}) to assess the threshold criteria (overall protection of human health and the environment, and attainment of ARARs). Each alternative was evaluated to ascertain the degree of risk reduction achieved, either through reduced contaminant loading to an exposure pathway or reduced surface area available for certain exposures. The resulting risk reduction estimates were then compared with one another to evaluate whether the relative risk reduction provided by a specific alternative is greater than another; these risk reductions were also compared with the reduction required to alleviate excess risk via the specific pathway or media. The risk reduction models also estimated resultant contaminant concentrations in the various media, which were then compared with medium and contaminant-specific ARARs.

Modeling estimates and assumptions were used in an attempt to quantify risk reduction and evaluate whether ARARs would be attained. Several assumptions and estimates were used in this analysis. Some of the assumptions were based on standard CERCLA risk assessment guidance, while others were based on site-specific observation and professional judgment. Many of the estimates were based on conservative or worst case scenarios, but since alternatives were compared with one another, these assumptions were consistent. The evaluation findings should, therefore, not be considered absolute; however, the relative risk reduction differences between alternatives are meaningful and can be used to evaluate this criterion.

The human health risk assessment considered the recreational receptor to be the most significant exposure pathway at the Spring Meadow Lake site under the rockhound/goldpanner (RH GP) scenario. The on-site worker exposure scenario is considered to be the most significant exposure pathway at the Montana Wildlife Center. No potential residential scenarios exist at the Spring Meadow Lake site. The screening level risk assessments completed for the Spring Meadow Lake site identified arsenic and lead as the

contaminants of concern for human exposure. For the Spring Meadow Lake scenario 400 mg/kg lead and 550 mg/kg arsenic were determined to be the maximum acceptable contaminant levels. The maximum acceptable contaminant levels for the Montana Wildlife Center were determined to be 750 mg/kg lead and 230 mg/kg arsenic. (See Table 5-17).

Reduction of human health risks posed by the wastes found at the Spring Meadow Lake site is best addressed by reducing the area of exposed wastes, either by covering or removing contaminated wastes. The evaluation of methods to reduce the exposed contaminated surface area must also consider the long-term stability and eventual partial failure of cover or containment systems.

The ecological risk assessment identified three exposure scenarios as determined by EQs greater than one: (1) plant phytotoxicity to arsenic and lead; (2) deer ingestion of lead; and (3) surface water aquatic life exposure to arsenic contaminated submerged surface soil. The deer ingestion scenario would likely require a reduction in surface soil lead levels to achieve no potential risks to deer. The plant phytotoxicity scenario also requires a reduction in arsenic and lead surface concentrations or exposed surface area to achieve no phytotoxic effects (EQ less than or equal to 1). Reduction in phytotoxic effects will be achieved through exposure reduction activities associated with the human health risk exposure evaluations.

The maximum exposure concentrations for the East Arm area are: 10,400 mg/kg arsenic and 6,180 mg/kg lead. The amount of contaminant reduction required to meet recreational cleanup guidelines at the East Arm area are 95 percent for arsenic and 94 percent for lead. The maximum exposure concentrations for the Montana Wildlife Center are: 33,700 mg/kg arsenic and 16,300 mg/kg lead. The amount of contaminant reduction required to meet on-site worker cleanup guidelines at the Montana Wildlife Center are 99 percent for arsenic and 95 percent for lead. For plant phytotoxicity the concentrations must be reduced for arsenic by 99 percent and lead by 99 percent.

6.5.2 Alternative 1: No-Action

Under this alternative, no reclamation activities would be implemented. Consequently, long-term human health and environmental risks associated with the on-site contamination are assumed to remain unchanged. The no-action alternative is used to provide a baseline for comparing other alternatives and is included as required under CERCLA and the NCP.

6.5.2.1 Overall Protection of Human Health and the Environment

The no-action alternative provides no control of exposure to the contaminated materials and no reduction in risk to human health or the environment. Under this alternative, site contaminants would continue to migrate to air, groundwater, and surface water.

Protection of human health would not be achieved under the no-action alternative. Prevention of direct human exposure through the pathways of concern would not be achieved. Ingestion, dermal contact, and inhalation of soil containing metals would not be reduced. Protection of the environment would also not be achieved under the no-action alternative. Risks posed by ecological exposures through all scenarios would remain unchanged.

6.5.2.2 Compliance with ARARs

A comprehensive list of federal and state ARARs is presented in Appendices 6-A and 6-B. ARARs are divided into contaminant-specific, location-specific, and action-specific requirements. Under the no-action alternative, no contaminated materials would be treated, removed, or actively managed. Leaching and releases of contaminants to groundwater and surface water would not be reduced under this alternative and surface water standards would continue to be exceeded.

6.5.2.3 Long-Term Effectiveness and Permanence

Under the no-action alternative, no controls or long-term measures would be imposed on the contaminated materials at the site; consequently, this alternative provides no long-term effectiveness. Therefore, the no-action alternative would not be effective at minimizing risks from exposure to site wastes.

6.5.2.4 Reduction of Toxicity, Mobility or Volume through Treatment

The no-action alternative would not reduce the toxicity, mobility, or volume of the contaminated materials.

6.5.2.5 Short-Term Effectiveness

The no-action alternative would not create any short-term risks.

6.5.2.6 Implementability

The no-action alternative is readily implementable.

6.5.2.7 Costs

No direct monetary costs are associated with the no-action alternative.

6.5.3 Alternative 2: Institutional Controls

Institutional controls were retained as a reclamation alternative for the Spring Meadow Lake site. This alternative would involve maintaining current land-use of the Spring Meadow Lake site as a state park and as a wildlife rehabilitation area. Future land-use scenarios such as residential development of the Spring Meadow Lake site would be prohibited.

Institutional control measures including fencing and are not considered to be a feasible reclamation alternative for reducing exposure to contaminated soils and mineral processing wastes at the Spring Meadow Lake. More aggressive institutional controls such as fencing would significantly interfere or impact the use of the Spring Meadow Lake site as a recreational and wildlife rehabilitation area.

6.5.3.1 Overall Protection of Human Health and the Environment

This alternative would provide some protection of human health by restricting land uses that would result in greater risk.

6.5.3.2 Compliance with ARARs

There are no federal or state contaminant-specific ARARs that are required to be met for applying institutional controls at the Spring Meadow Lake site. However, leaching and releases of contaminants to

groundwater and surface water would not be reduced under this alternative and exceedences of surface water standards would remain unchanged.

Occupational Safety and Health Administration (OSHA) requirements would be met by requiring appropriate safety training for all on-site workers during the construction phase.

Location-specific ARARs are expected to be met without any conflicts. Contacts with appropriate agencies regarding wetlands, flood plains, and historical, cultural, and paleontological remains would be required.

All action-specific ARARs are anticipated to be met.

6.5.3.3 Long-Term Effectiveness and Permanence

Under the institutional controls alternative, land use controls at the Spring Meadow Lake site are considered to have long-term effectiveness so long as these measures are maintained and enforced.

6.5.3.4 Reduction of Toxicity, Mobility or Volume through Treatment

Waste toxicity, mobility, and volume are not reduced under the institutional controls alternative.

6.5.3.5 Short-Term Effectiveness

There is no construction phase associated with this alternative; therefore, no short-term impacts exist.

6.5.3.6 Implementability

This alternative is both technically and administratively feasible, and could be implemented immediately.

6.5.3.7 Costs

The estimated total present worth cost for Alternative 2 (institutional controls) is \$11,267.05. Table 6-5 present the costs associated with implementing this alternative. The total cost includes the present value of 30 years of annual maintenance and monitoring costs, in addition to the capital costs.

**TABLE 6-5
COST ESTIMATE
ALTERNATIVE 2
INSTITUTIONAL CONTROLS
SPRING MEADOW LAKE SITE**

Cost Item	Quantity	Unit	Unit Cost (a)	Cost
Capital Costs				
Land Use Controls-Deed Restrictions	1	LS	\$ 5,000.00	\$ 5,000.00
Subtotal Construction Costs				\$ 5,000.00
Construction Contingencies	Percent of Construction Costs =		0%	\$ -
Engineering Design and Construction Oversight	Percent of Construction Costs =		0%	\$ -
TOTAL CAPITAL COSTS				\$ 5,000.00
Yearly Operation and Maintenance (O&M) Costs				
Site Inspections	1	EA	\$ 500.00	500.00
Site Maintenance	Percent of Construction Costs =		0%	\$ -
Subtotal O&M Costs				\$ 500.00
O&M Contingencies		1%		\$ 5.00
Total Yearly O&M Cost				\$ 505.00
Present Worth of O&M Costs Based on 30 Year Life @ 7%		PW FACTOR	12.41	\$ 6,267.05
TOTAL PRESENT WORTH				\$ 11,267.05

(a) Unit costs are based on professional judgment.

Notes:

LS = Lump Sum

CY = Cubic Yard

SY = Square Yard

LF = Lineal Feet

% = Percent

EA = Each

PW = Present Worth

6.5.4 Alternative 3: Containment

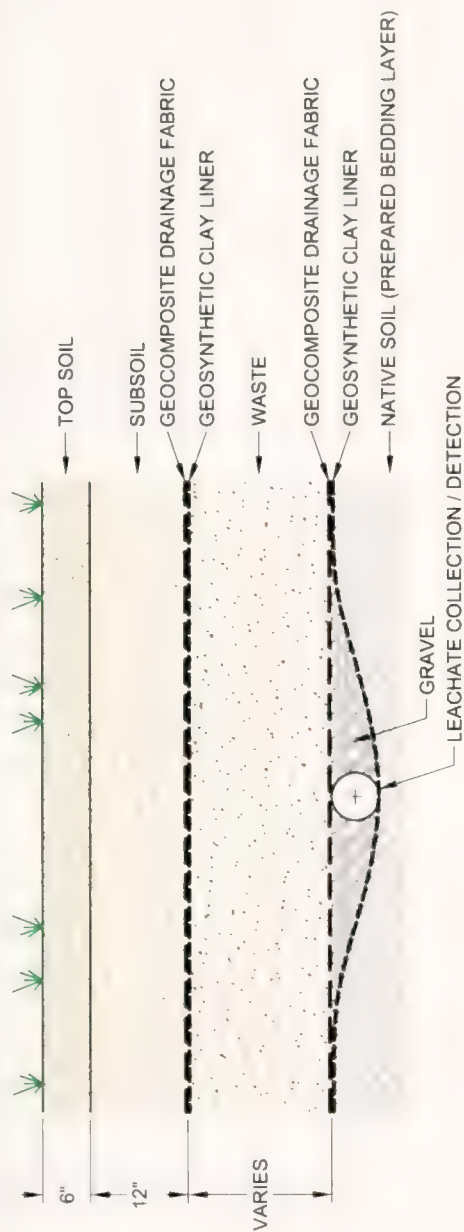
This alternative would include containing wastes on site. Containing wastes in place would involve surface control measures and the construction of a multilayer geotextile and soil cap. The containment steps would include the following: (1) consolidating and regrading the materials; (2) capping the area; and (3) revegetating the disturbed areas and the cap. Storm water and other surface control measures would also be implemented to minimize potential erosion. Specific site-wide containment steps would include the following:

- Montana Wildlife Center and East Arm area: Contaminated soils and mineral processing wastes within the Montana Wildlife Center and in isolated waste areas in the East Arm area would be excavated and consolidated with other wastes. Consolidated wastes would subsequently be graded, compacted and contained with an earthen and geomembrane cap. Slopes and drainage pathways would be graded to blend with natural contours and topography to allow for positive drainage.
- Spring Meadow Lake Submerged Soils: Contaminated submerged surface soil along the shoreline of Spring Meadow Lake would be excavated and consolidated with other wastes away from the lake and then capped with an earthen and geomembrane cap. This would be done to isolate the submerged soil from human and ecological contact.

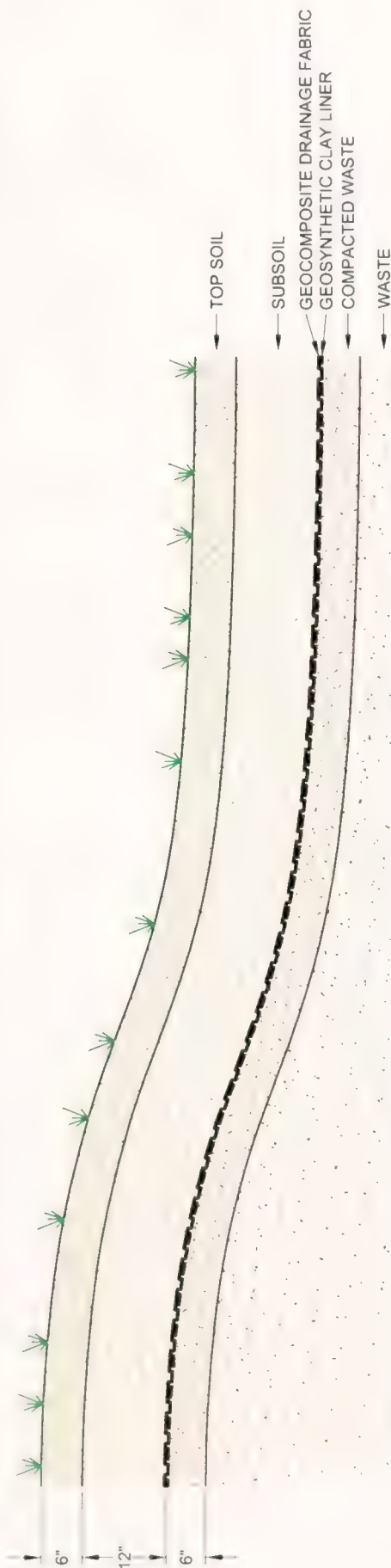
In all applicable waste areas, surface control measures would use selective grading, coversoil application, and revegetation activities to reestablish drainage channels, minimize erosion, and help establish self-perpetuating plant communities. Consolidation involves pushing and hauling the waste into common and smaller areas.

The waste areas would be regraded and recontoured to reestablish surface water drainage channels, minimize erosion, and achieve positive drainage away from capped areas and towards the lake. Slopes steeper than about 4:1 would be regraded to small terrace benches, dozer basins, and pits to minimize soil erosion and enhance revegetation efforts.

Installation of an earthen and geomembrane cap would include a 6-inch layer of compacted soil or fine-grained waste cushion, a geomembrane or geosynthetic clay liner, and a geocomposite drainage layer, all beneath the 18-inch earthen cap (see Figure 6-2).



MODIFIED RCRA SUBTITLE C REPOSITORY



EARTHEN AND GEOMEMBRANE CAP



Tetra Tech EM Inc.

Spring Meadow Lake
Helena, Montana

FIGURE 6-2
REPOSITORY AND CAP
CONCEPTUAL DESIGN



Revegetation of the area would likely take place during the fall season. The seed mixture and fertilizer would be simultaneously drilled into the prepared seed beds. Mulch would be applied to promote temporary protection of the disturbed erodible surfaces. Some of the steeper slopes may require seeding with a hydromulch seeder followed by covering with soil erosion control blankets. Selected areas may be interseeded with bare-root or containerized shrub and tree species. Biodegradable jute netting, or the most appropriate erosion control mat, would be anchored over newly seeded areas with slopes greater than 2.5 to 1 to provide additional stabilization until the vegetation becomes established. Also, any temporary roads constructed at the site would be reclaimed after the field activities are completed.

6.5.4.1 Overall Protection of Human Health and the Environment

The implementation of this alternative would provide an additional level of protection beyond that provided by institutional control measures (Alternative 2) by further reducing the threat of direct contact with the waste material, as well as reducing the risk of airborne exposure. Containing waste and subsequent revegetation would stabilize the surface by providing additional erosion protection, and decrease the infiltration of precipitation and surface water runoff that may leach contaminants to the groundwater.

The threat of direct human and ecological exposure in the East Arm area, Montana Wildlife Center and to Spring Meadow Lake submerged soils would be virtually eliminated by this alternative over the long term, contingent upon proper maintenance of earthen and vegetative caps. The addition of an earthen and geomembrane cap would further reduce the threat of direct human exposure as compared to surface control measures alone. Water quality would also be improved and fish exposure would be reduced by the removal and capping of the submerged soils. Ingestion and dermal contact, and inhalation of soil containing arsenic, lead, and manganese would be reduced to acceptable levels. Environmental and ecological exposures through all scenarios including deer ingestion of lead and plant phytotoxicity would also be virtually eliminated over the long term. Releases of contaminants due to precipitation leaching would be significantly reduced by the earthen and geomembrane cap.

Due to the risk analysis being based on recreational use and to ensure that human health standards are not exceeded, future use of the land should be restricted to recreational uses.

6.5.4.2 Compliance with ARARs

There are no federal or state contaminant-specific ARARs that are required to be met for containing contaminated mine wastes in place at the Spring Meadow Lake site. However, leaching and releases of contaminants to groundwater and surface water would be significantly reduced because the primary waste sources of concern would be physically isolated using an earthen and geomembrane cap. These actions are expected to satisfy federal and state surface water and groundwater standards including maximum contaminant levels (MCL) and human health standards (HHS) over the long term.

OSHA requirements would be met by requiring appropriate safety training for all on-site workers during the construction phase.

Location-specific ARARs are expected to be met without any conflicts. Contacts with appropriate agencies regarding wetlands, floodplains, and historical, cultural, and paleontological remains would be required.

All action-specific ARARs are anticipated to be met including the hydrological regulations contained in the Strip and Underground Mine Reclamation Act. The mining wastes were derived from the beneficiation and extraction of ores and are, therefore, assumed to be exempt from federal government regulation through RCRA as hazardous waste. In addition, revegetation requirements contained in the Surface Mining Control and Reclamation Act would be met. State of Montana dust suppression and control requirements are applicable for earth-moving activities associated with this alternative for the control of fugitive dust emissions; these requirements would be met through water application to roads receiving heavy vehicular traffic and to excavation areas, if necessary.

6.5.4.3 Long-Term Effectiveness and Permanence

Under this alternative, the cap would require periodic inspection to ensure that the vegetation becomes established and continues to perform as designed. Consequently, long-term monitoring and maintenance would be required, especially monitoring and maintenance of revegetated slopes at the site since areas would be susceptible to erosion. The soil cover would be the component most vulnerable to any damage or degradation that might occur. The soil cover would be susceptible to settlement, surface water ponding, erosion, and disruption of cover integrity by vehicle and foot traffic, deep-rooting vegetation, and burrowing animals. The actual design life of the cap is not certain; however, since the cap would be

periodically inspected, the required maintenance could be determined and implemented. In addition, institutional controls would be required to prevent land uses incompatible with the reclaimed site. Specifically, land uses that would compromise the waste cover should be precluded.

The long-term effectiveness of covering or capping the waste in place would be enhanced by determining the proper cover or cap design and appropriate grading layout, and by selecting the appropriate plant species for revegetation. Long-term effectiveness would likely be improved by selecting appropriate site adapted plant species for the revegetation seed mixture.

6.5.4.4 Reduction of Toxicity, Mobility, or Volume through Treatment

The objective of this alternative is to reduce contaminant mobility; the volume or toxicity of the contaminants would not be physically reduced. Consolidating and containing the waste would stabilize these sources and reduce contaminant mobility from surface water and wind erosion with an increased risk reduction compared to institutional control measures alone (Alternative 2). The mobility of the contaminants is expected to be reduced to an extent that would result in an overall risk reduction from all pathways and routes of exposure.

The earthen and geomembrane cap would provide protection from surface water infiltration. Depending on the stability of the liner on steeper slopes; the drainage layer directly above the flexible membrane liner would effectively transport surface water infiltration away from waste materials. A drainage ditch would be installed at the bottom of the contoured area to capture any potential surface water infiltration from above the geomembrane liner. In addition, gases would not likely be generated by the inorganic waste materials; therefore, venting would not be required.

6.5.4.5 Short-Term Effectiveness

The construction phase of this alternative would likely be accomplished within one field season; therefore, impacts associated with construction would likely be short term and minimal. These potential short-term impacts would be mitigated during the construction phase. On-site workers would be adequately protected by using appropriate personal protective equipment and by following proper operating and safety procedures. However, short-term air quality impacts to the surrounding environment may occur due to the relatively large volumes of waste requiring consolidation and grading. Control of

fugitive dust emissions would be provided by applying water to surfaces receiving heavy vehicular traffic or in excavation areas, as needed.

Short-term impacts to the surrounding community are expected to be minimal. A measurable short-term impact to the surrounding community would include increased vehicular traffic and associated safety hazards in the vicinity of the Spring Meadow Lake in association with the construction. Dust generation may occur in the vicinity of Spring Meadow Lake and water application to the roads in the area may be necessary. Some recreational and professional use of the Spring Meadow Lake site would likely be interrupted or impacted during excavation and construction activities.

6.5.4.6 Implementability

This alternative is both technically and administratively feasible, and could be implemented within one field season. The consolidation, regrading, and revegetation require conventional construction practices; materials and construction methods are readily available. It is assumed that local sources for the earthen borrow material and coversoil (or suitable plant-growth media) are available. Also, design methods and requirements are well documented and understood. Installation of the geomembrane liner would require the services of a contractor experienced in the proper installation of specialized caps and liners.

The areas of Spring Meadow Lake have been identified as having submerged soil contamination in addition to supporting a significant population and variety of aquatic wildlife. Special concern would be needed during excavation of wet soil material in Spring Meadow Lake in order to minimize damage or disturbance to the excavation and surrounding areas. This is necessary not only to protect the aquatic wildlife inhabiting the lake, but to also minimize disruption to the professional/recreational activities on site. Construction activities would likely be limited to the use of small equipment working from the Spring Meadow Lake bank to minimize the amount of disturbance and invasiveness of excavation activities. Dewatering and/or dredging any section of Spring Meadow Lake would not be considered feasible or appropriate techniques for use.

Components or factors which could potentially prolong the implementation of this alternative as planned include: (1) locating adequate earthen borrow and coversoil (or suitable plant-growth media) sources; (2) controlling fugitive dust emissions and storm water discharge during reclamation activities; (3) addressing landowner concerns; and (4) addressing concerns involving regular recreational use. However, these concerns are applicable to other reclamation alternatives being considered for the site.

6.5.4.7 Costs

The estimated total present worth cost for Alternative 3 (containment in place with an earthen cap and geomembrane liner) is \$820,991.97. Table 6-6 present the costs associated with implementing this alternative. The total cost includes the present value of 30 years of annual maintenance and monitoring costs, in addition to the capital costs.

Conceptual Design and Assumptions

The following assumptions were used to develop costs directly and to calculate associated costs for this alternative:

- Approximately 8 acres would be prepared as part of construction activities. Preparation would include clearing, grubbing, and installation of stormwater controls. Existing trees along the edge of the east arm would be left in place. Waste would be excavated around trees in such a manner as to minimize damage to the roots.
- Approximately 3,400 cubic yards (cy) of submerged soils and isolated wastes would be excavated and consolidated with other wastes.
- Approximately 29,200 square yards of waste surface would be re-graded and covered with a geomembrane cap. (The graded and contoured area must be smooth enough to allow the installation of the cap and to maximize the integrity of the cap).
- An 18-inch soil cover would be placed over the geomembrane cap. Approximately 14,600 cy of off-site soils (borrow and cover) would be imported to cover the geomembrane cap. Soil borrow and cover soil sources are assumed located within a 5.0-mile radius of the site and would not require permitting.
- Excavated submerged soil and isolated waste areas would be backfilled to original grade with imported common borrow and covered with 6 inches of imported cover soil. A total of 3,400 cy of imported soil would be required. Surfaces would be graded and blended to match existing contours and topography.
- An erosion control fabric lined drainage ditch would be installed to control drainage around the capped area.
- A total of 8 acres of disturbed ground, including excavated areas, staging areas and haul roads would be revegetated with plant species appropriate for the Spring Meadow Lake site.
- Access roads within the site would be improved to allow unobstructed access for heavy equipment. Any temporary roads constructed at the site would be obliterated and reclaimed after the field activities were completed.

**TABLE 6-6
COST ESTIMATE
ALTERNATIVE 3
CONTAINMENT WITH AN EARTHEN AND GEOMEMBRANE CAP
SPRING MEADOW LAKE SITE**

Cost Item	Quantity	Unit	Unit Cost (a)	Cost
Capital Costs				
Mobilization, Bonding & Insurance	1	LS	\$ 50,000.00	\$ 50,000.00
Site Preparation and Storm Water Control	8	Acre	\$ 1,000.00	\$ 8,000.00
Road Improvement	1	Mile	\$ 5,000.00	\$ 5,000.00
Excavate and Consolidate Waste	3,400	CY	\$ 3.00	\$ 10,200.00
Geomembrane Cap	29,200	SY	\$ 12.00	\$ 350,400.00
Site Grading	29,200	SY	\$ 1.00	\$ 29,200.00
Drainage Ditch	700	LF	\$ 4.00	\$ 2,800.00
Offsite Soil Borrow	12,500	CY	\$ 4.00	\$ 50,000.00
Offsite Cover Soil	5,500	CY	\$ 8.00	\$ 44,000.00
Fertilize, Seed, and Mulch	8	Acre	\$ 1,500.00	\$ 12,000.00
Cleanup and Demobilization	1	LS	\$ 10,000.00	\$ 10,000.00
Subtotal Construction Costs				\$ 571,600.00
Construction Contingencies	Percent of Construction Costs =		15%	\$ 85,740.00
Engineering Design and Construction Oversight	Percent of Construction Costs =		15%	\$ 85,740.00
TOTAL CAPITAL COSTS				\$ 743,080.00
Yearly Operation and Maintenance (O&M) Costs				
Site Inspections	1	EA	\$ 500.00	500.00
Site Maintenance	Percent of Construction Costs =		1%	\$ 5,716.00
Subtotal O&M Costs				\$ 6,216.00
O&M Contingencies			1%	\$ 62.16
Total Yearly O&M Cost				\$ 6,278.16
Present Worth of O&M Costs Based on 30 Year Life at 7%		PW FACTOR	12.41	\$ 77,911.97
TOTAL PRESENT WORTH				\$ 820,991.97

(a) Unit costs are based on recent bids for similar work at other Montana abandoned mine reclamation projects and professional judgment

Notes:

LS = Lump Sum

CY = Cubic Yard

SY = Square Yard

LF = Lineal Feet

% = Percent

EA = Each

PW = Present Worth

6.5.5 Alternative 4: Excavation and On-Site Disposal in a Repository

Under this alternative, waste materials at the site would be excavated and disposed of in one on-site repository. The steps include the following: (1) excavating and preparing the repository subgrade, (2) installing liner and leachate collection system, (3) excavating and consolidating the waste materials in the repository, (4) backfilling, grading, and placing cover soil over the excavated areas; (5) capping the waste with an a geocomposite liner and an 18-inch thick earthen cap, and (6) revegetating the repository cap and the disturbed areas. The available space in the East Area would be large enough to site a repository to store all contaminated soils and mineral processing waste excavated from the Spring Meadow Lake site (see Figure 6-1). Due to the relatively flat topography of the Eastern Area, an on-site repository would likely need to be above ground to allow for adequate drainage of leachate from the repository.

Wastes would be graded and compacted as they are placed in the repository. A geocomposite liner and 18 inches of soil cover would be placed over the waste (see Figure 6-2).

After the soil cover is placed over the waste, the repository slopes would be graded to 3 to 1 slopes or less, while maintaining an 18-inch minimum soil cover depth, to minimize surface erosion potential. Next, the disturbed areas would be prepared for revegetation, including the removal areas and the repository cap. Submerged soil areas and the Foundry area would be backfilled to original grade. The excavated areas would be graded to match the contour of the land surface and cover soil would be applied to the disturbed areas.

Revegetation would likely take place during the fall of the year. The seed mixture and fertilizer would be simultaneously drilled into the prepared seed beds. Mulch would be applied to promote temporary protection of the disturbed erodible surfaces.

Heavy equipment would be required on site to implement this alternative efficiently. Multiple large-capacity haul trucks, bulldozers, front-end loaders, excavators, and compactors would be needed to construct the repository and excavate and haul the material. Smaller-capacity equipment, such as skid-steer loaders, backhoes and small haul trucks would be employed in space-restrictive areas.

6.5.5.1 Overall Protection of Human Health and the Environment

The implementation of this alternative would provide a means of reducing or eliminating the threat of direct contact with the waste material as well as reducing the risk of airborne exposure and soil ingestion. In addition, isolating the waste would provide environmental protection by limiting the infiltration of precipitation and surface water that may leach contaminants to the groundwater.

The threat of direct human exposure would essentially be eliminated by this alternative. The potential for ingestion, dermal contact, and inhalation of soil containing arsenic and lead would be eliminated over the long term. Risks would be reduced to acceptable levels for recreational land uses. Due to the risk analysis being based on recreational use and to ensure that human health standards are not exceeded, future use of the land should be restricted to recreational uses.

Protection of the environment would be achieved under this alternative. Ecological exposures through all scenarios including deer exposure to arsenic and lead through ingestion of surface salts, phytotoxic concentrations of metals, and exposure of aquatic organisms to arsenic in submerged soils would also be reduced to acceptable levels or possibly eliminated.

6.5.5.2 Compliance with ARARS

There are no federal or state contaminant-specific ARARs that are required to be met for containing contaminated mineral processing waste at the Spring Meadow Lake site. However, removal of the specified waste and disposal in a constructed repository are expected to satisfy federal and state surface water and groundwater standards including MCL and HHS. The contaminants would not be expected to leach to surface water or groundwater because the primary waste sources of concern would be physically isolated from groundwater using soil and liner cap.

Implementation of this alternative is expected to satisfy air quality regulations because encapsulating the waste would stabilize the materials with respect to fugitive emissions.

OSHA requirements would be met by requiring appropriate safety training for all on-site workers during the construction phase of the project.

Location-specific ARARs are expected to be met without any conflicts. Contacts with appropriate agencies regarding wetlands, floodplains, and paleontological resources would be required.

All action-specific ARARs are anticipated to be met including the hydrological regulations contained in the Strip and Underground Mine Reclamation Act. The mining wastes were derived from the beneficiation and extraction of ores and are, therefore, assumed to be exempt from federal government regulation through RCRA as hazardous waste. In addition, revegetation requirements contained in the Surface Mining Control and Reclamation Act would be met. State of Montana dust suppression and control requirements are applicable for earth-moving activities associated with this alternative for the control of fugitive dust emissions; these requirements would be met through water application to roads receiving heavy vehicular traffic and to excavation areas, if necessary.

6.5.5.3 Long-Term Effectiveness and Permanence

The long-term effectiveness and permanence of the repository is dependent upon proper maintenance, including long-term monitoring and routine inspections, to ensure that the system performs as designed. The repository cap would be the component most vulnerable to any damage or degradation that might occur. Multilayered caps are susceptible to erosion, settlement, and disruption of the cover integrity by vehicles, deep-rooting vegetation, and burrowing animals. Multilayer caps are also susceptible to ponding of surface water. The actual design life of the repository is not certain; however, since the repository would be periodically inspected, the required maintenance could be determined and implemented. In addition, institutional controls would be required to prevent land uses incompatible with the reclaimed site. Specifically, land uses that would compromise the repository cap should be precluded.

In addition, revegetation of the excavated areas and the repository cap would stabilize the land surface by providing erosion protection from surface water and wind erosion, and would reduce net infiltration through the media by increasing the evapotranspiration process. Determining the proper grading layout for the area, selecting good quality soil cover, and selecting the appropriate plant species for revegetation would enhance the long-term effectiveness of this alternative. Long-term effectiveness would likely be improved by selecting appropriate site adapted plant species adapted to short growing seasons.

6.5.5.4 Reduction of Toxicity, Mobility or Volume through Treatment

The objective of this alternative is to provide a reduction in contaminant mobility although the waste is not treated. The volume or toxicity of the contaminants would not be physically reduced. Placing the mineral processing waste in a repository would stabilize the source area and reduce and possibly eliminate contaminant mobility from surface water and wind erosion through the use of impermeable liners that encapsulate the mineral processing waste. A drainage ditch would be installed at the bottom of the contoured area to capture any potential surface water infiltration from above the geomembrane liner. The mobility of the contaminants would be reduced to an extent that would result in an overall risk reduction from all pathways and routes of exposure.

6.5.5.5 Short-Term Effectiveness

The construction phase of this alternative would likely be accomplished within one field season; therefore, impacts associated with construction would likely be short term and minimal. These potential short-term impacts would be mitigated during the construction phase. On-site workers would be adequately protected by using appropriate personal protective equipment and by following proper operating and safety procedures. However, short-term air quality impacts to the surrounding environment may occur due to waste consolidation and grading. Control of fugitive dust emissions would be provided by applying water to surfaces receiving heavy vehicular traffic or in excavation areas, as needed. Short-term impacts to people residing or recreating in the vicinity of the site are expected to be minimal. A measurable short-term impact to the surrounding area would include increased vehicular traffic, associated safety hazards, and potential dust generation in the vicinity of Spring Meadow Lake and the Montana Wildlife Center in association with construction. Some recreational and professional use of the Spring Meadow Lake would be interrupted or impacted during excavation and construction activities.

6.5.5.6 Implementability

Depending upon the availability of an on-site area for a repository, this alternative is technically and administratively feasible, and could be implemented within one field season. The construction of a repository with a multilayered cap is considered a conventional construction practice; materials and construction methods are readily available. Constructing the repository may require the services of a contractor experienced in the proper component installation procedures. Also, design methods and requirements are well documented and understood.

Components or factors which could potentially prolong the implementation of this alternative as planned include: (1) locating a repository area on-site, (2) locating adequate earthen borrow and coversoil (or suitable plant-growth media) sources; (3) controlling fugitive dust emissions and storm water discharge during reclamation activities; (4) addressing landowner concerns; and (5) addressing concerns involving regular recreational use. However, most of these concerns are applicable to other reclamation alternatives being considered for the site. The availability of an on-site repository area is uncertain at this time.

6.5.5.7 Costs

The estimated total present worth cost for Alternative 4, excavation and on-site disposal in an earthen and geomembrane capped repository, is \$950,320.28. Table 6-7 presents the itemized capital and operations and maintenance costs associated with implementing this alternative.

Conceptual Design Assumptions

The following assumptions were used to develop costs directly and to calculate associated costs for this alternative:

- Access roads through the site would be improved to allow unobstructed access for heavy equipment. Any temporary roads constructed at the site would be obliterated and reclaimed after the field activities were completed.
- Approximately 12 acres would be prepared as part of construction activities. Preparation would include grubbing and installation of stormwater controls. Existing trees along the edge of the east arm would be left in place. Waste would be excavated around trees in such a manner as to minimize damage to the roots.
- A repository with a total surface area of approximately 2.5 acres would be prepared on site. Approximately 6,050 cy of soil would be excavated from the repository area and used later for the cap.
- A bottom geocomposite liner would be installed in the repository consisting of a geosynthetic clay liner and a geocomposite drainage fabric.
- A leachate collection and removal system would be installed in the repository consisting of PVC drain pipes surrounded by a three-inch thick layer of washed, coarse gravel. An evaporation tank would be installed to collect all leachate. The evaporation tank would be surrounded by a chain link fence.
- An estimated 34,300 cy of contaminated soil, mineral processing wastes, and submerged soils would be excavated, consolidated and compacted in the repository using excavators, scrapers and dozers.

TABLE 6-7
COST ESTIMATE
ALTERNATIVE 4
ON-SITE MODIFIED RCRA REPOSITORY WITH GEOMEMBRANE LINER AND EARTHEN
AND GEOMEMBRANE CAP
SPRING MEADOW LAKE SITE

Cost Item	Quantity	Unit	Unit Cost (a)		Cost
Capital Costs					
Mobilization, Bonding & Insurance	1	LS	\$	55,000.00	\$ 55,000.00
Site Preparation and Storm Water Control	12	Acre	\$	1,000.00	\$ 12,000.00
Road Improvement	1	Mile	\$	5,000.00	\$ 5,000.00
Repository Excavation and Base Preparation	6,050	CY	\$	2.50	\$ 15,125.00
Repository Geomembrane Liner	12,100	SY	\$	12.00	\$ 145,200.00
Leachate Collection System Piping	500	LF	\$	8.00	\$ 4,000.00
Leachate Collection and Disposal Tank	1	LS	\$	4,000.00	\$ 4,000.00
Waste Excavation, Hauling and Compaction	34,300	CY	\$	3.00	\$ 102,900.00
Repository Geomembrane Cap	12,100	SY	\$	12.00	\$ 145,200.00
Repository Cap Soil	6,050	CY	\$	3.00	\$ 18,150.00
Run-on/Run-off Ditches	700	LF	\$	4.00	\$ 2,800.00
Offsite Soil Borrow	17,200	CY	\$	4.00	\$ 68,800.00
Cover Soil	5,600	CY	\$	8.00	\$ 44,800.00
Fertilize, Seed, and Mulch	12	Acre	\$	1,500.00	\$ 18,000.00
Chain Link Fence	160	LF	\$	20.00	\$ 3,200.00
Woven Wire Farm Fence	1,360	LF	\$	6.00	\$ 8,160.00
Cleanup and Demobilization	1	LS	\$	10,000.00	\$ 10,000.00
Subtotal Construction Costs					\$ 662,335.00
Construction Contingencies	Percent of Construction Costs =		15%		\$ 99,350.25
Engineering Design and Construction Oversight	Percent of Construction Costs =		15%		\$ 99,350.25
TOTAL CAPITAL COSTS					\$ 861,035.50
Yearly Operation and Maintenance (O&M) Costs					
Site Inspections	1	EA	\$	500.00	500.00
Site Maintenance	Percent of Construction Costs =		1%		\$ 6,623.35
Subtotal O&M Costs					\$ 7,123.35
O&M Contingencies			1%		\$ 71.23
Total Yearly O&M Cost					\$ 7,194.58
Present Worth of O&M Costs Based on 30 Year Life at 7%		PW FACTOR	12.41		\$ 89,284.78
TOTAL PRESENT WORTH					\$ 950,320.28

(a) Unit costs are based on recent bids for similar work at other Montana abandoned mine reclamation projects and professional judgment.

Notes:

LS = Lump Sum

CY = Cubic Yard

SY = Square Yard

LF = Lineal Feet

% = Percent

EA = Each

PW = Present Worth

- A repository cap would be installed consisting of a geosynthetic clay liner and geocomposite drainage fabric. The geocomposite cap would be covered with 18 inches of imported cover soil removed from the repository prior to construction totaling approximately 6,050 cy.
- An erosion control fabric lined ditch would be installed to control run-on/run-off around the repository.
- Excavated areas at the East Arm area and Montana Wildlife Center (approximately 7 acres) would be backfilled with imported common borrow to approximately 50 percent of the total amount of removed material or 17,200 cy. Surfaces would be graded and blended to match existing contours and topography then covered with 6-inches of imported cover soil (5,600 cy). It is assumed that borrow soil and coversoil sources are located within a 5.0-mile radius of the site and would not require permitting.
- A total of 12 acres of disturbed ground, including excavated areas, staging areas and haul roads would be revegetated with plant species appropriate for the Spring Meadow Lake site.
- A woven wire fence would be installed around the repository to minimize potential vehicular or foot traffic. The total length of fence required to surround the repository would be approximately 1,360 linear feet. A chain link fence of approximately 160 linear feet would be installed around the leachate tank.

6.5.6 Alternative 5: Excavation and Relocation with Other Mine Wastes at Basin Creek Mine LP1

Under this alternative, mineral processing wastes and contaminated soils at the Spring Meadow Lake site would be excavated and consolidated with other mine wastes off-site. The steps include the following: (1) improving access roads within the Spring Meadow Lake site; (2) excavating and hauling waste materials to Basin Creek Mine LP1 and consolidating the materials with other mine wastes at LP1; (3) backfilling, grading, and placing cover soil over the excavated areas; and (4) revegetating the disturbed areas at site. The haul route to LP1 currently considered feasible includes hauling through Helena, then by Interstate 15 south to Basin, then by the Basin Creek Road to LP1. Hauling wastes via Ten Mile Creek and the town of Rimini is not presently considered feasible due to conflicts with EPA remediation and construction activities in these areas.

The disturbed areas would be prepared for revegetation, including the removal areas, staging areas and soil borrow areas. The excavated areas would be graded to match the contour of the land surface and, if necessary, cover soil would be applied to the disturbed areas.

Revegetation would likely take place during the fall of the year. The seed mixture and fertilizer would be simultaneously drilled into the prepared seed beds. Mulch would be applied to promote temporary protection of the disturbed erodible surfaces.

Heavy equipment would be required on site to implement this alternative efficiently. Multiple large-capacity haul trucks, bulldozers, front-end loaders, excavators, and compactors would be needed to excavate and haul the material.

Any saturated material excavated from Spring Meadow Lake would either be dried prior to being transported, or transported in covered trucks with lined, leak-proof beds.

6.5.6.1 Overall Protection of Human Health and the Environment

The implementation of this alternative would provide a means of reducing or eliminating the threat of direct contact with the waste material as well as reducing the risk of airborne exposure and soil ingestion. In addition, removing the waste from the site and isolating the waste at LP1 would provide environmental protection by limiting the infiltration of precipitation and surface water that may leach contaminants to the groundwater.

The threat of direct human exposure would essentially be eliminated by this alternative. The potential for ingestion, dermal contact, and inhalation of soil containing arsenic and lead would be eliminated over the long term. Risks would be reduced to acceptable levels for recreational land uses. Due to the risk analysis being based on recreational use and to ensure that human health standards are not exceeded, future use of the land should be restricted to recreational uses.

Protection of the environment would be achieved under this alternative. Ecological exposures through all scenarios including deer exposure to lead through ingestion of surface salts, and plant phytotoxicity would also be reduced to acceptable levels or possibly eliminated.

6.5.6.2 Compliance with ARARS

There are no federal or state contaminant-specific ARARs that are required to be met for consolidating contaminated mineral processing waste at LP1. However, removal of the specified waste and relocation at LP1 are expected to satisfy federal and state surface water and groundwater standards including MCL.

and HHS. The contaminants would not be expected to leach to surface water or groundwater because the primary waste sources of concern would be removed from the site and physically isolated from groundwater at the Basin Creek Mine using a liner system and a liner cap.

Implementation of this alternative is expected to satisfy air quality regulations because waste would be removed from the site and encapsulating the waste would stabilize the materials with respect to fugitive emissions.

OSHA requirements would be met by requiring appropriate safety training for all on-site workers during the construction phase of the project.

Location-specific ARARs are expected to be met without any conflicts. Contacts with appropriate agencies regarding wetlands, floodplains, and paleontological resources would be required.

All action-specific ARARs are anticipated to be met including the hydrological regulations contained in the Strip and Underground Mine Reclamation Act. The mining wastes were derived from the beneficiation and extraction of ores and are, therefore, assumed to be exempt from federal government regulation through RCRA as hazardous waste. In addition, revegetation requirements contained in the Surface Mining Control and Reclamation Act would be met. State of Montana dust suppression and control requirements are applicable for earth-moving activities associated with this alternative for the control of fugitive dust emissions; these requirements would be met through water application to roads receiving heavy vehicular traffic and to excavation areas, if necessary.

6.5.6.3 Long-Term Effectiveness and Permanence

The long-term effectiveness and permanence of this alternative is dependent upon proper maintenance, including long-term monitoring and routine inspections, to ensure that the system performs as designed. Mine wastes would be capped at LP1 and the cap would be the component most vulnerable to any damage or degradation that might occur. Multilayered caps are susceptible to ponding of surface water, erosion, settlement, and disruption of the cover integrity by vehicles, deep-rooting vegetation, and burrowing animals. The actual design life of LP1 is not certain; however, since LP1 would be periodically inspected, the required maintenance could be determined and implemented. In addition, institutional controls would be required to prevent land uses incompatible with the reclaimed site. Specifically, land uses that would compromise the LP1 cap should be precluded.

In addition, revegetation of the excavated areas would stabilize the land surface by providing erosion protection from surface water and wind erosion, and would reduce net infiltration through the media by increasing the evapotranspiration process. Determining the proper grading layout for the area, selecting good quality soil cover, and selecting the appropriate plant species for revegetation would enhance the long-term effectiveness of this alternative. Long-term effectiveness would likely be improved by selecting metal tolerant plant species adapted to short growing seasons.

6.5.6.4 Reduction of Toxicity, Mobility or Volume through Treatment

The objective of this alternative is to provide a reduction in contaminant mobility although the waste is not treated. The volume or toxicity of the contaminants would not be physically reduced. Consolidating the mineral processing waste in with other mine waste at LP1 would eliminate the solid media from the source area and reduce contaminant mobility through surface water and wind erosion. The contaminated material in LP1 would be stabilized through the use of impermeable liners that encapsulate the mineral processing waste. The mobility of the contaminants would be reduced to an extent that would result in an overall risk reduction from all pathways and routes of exposure.

6.5.6.5 Short-Term Effectiveness

The construction phase of this alternative would likely be accomplished within one field season; therefore, impacts associated with construction would likely be short term and minimal. These potential short-term impacts would be mitigated during the construction phase. On-site workers would be adequately protected by using appropriate personal protective equipment and by following proper operating and safety procedures. However, short-term air quality impacts to the surrounding environment may occur due to waste excavation, hauling, and relocation. Control of fugitive dust emissions would be provided by applying water to surfaces receiving heavy vehicular traffic or in excavation areas, as needed. Short-term impacts to people residing or recreating in the vicinity of the site are expected to be minimal. A measurable short-term impact to the surrounding area would include increased vehicular traffic, particularly through the city of Helena and the town of Basin, associated safety hazards, and potential dust generation at the Spring Meadow Lake and Basin Creek Mine in association with construction. Some recreational and professional use of the Spring Meadow Lake would be interrupted or impacted during excavation and construction activities.

6.5.6.6 Implementability

This alternative is technically feasible, and could be implemented within one field season. The excavation of mineral processing waste and relocation in LP1 is considered a conventional construction practice; materials and construction methods are readily available. Also, design methods and requirements are well documented and understood.

Components or factors which could potentially prolong the implementation of this alternative as planned include: (1) locating adequate earthen borrow and coversoil (or suitable plant-growth media) sources; (2) controlling fugitive dust emissions and storm water discharge during reclamation activities; (3) addressing landowner concerns; and (4) addressing concerns involving regular recreational use. However, these concerns are applicable to other reclamation alternatives being considered for the site. An additional concern specifically related to this alternative would be scheduling excavation activities concurrent with the completion of other construction activities at LP1. Construction at LP1 is expected to be completed by the fall of 2006 and relocation after that time may not be possible.

6.5.6.7 Costs

The estimated total present worth cost for Alternative 5, excavation and relocation in LP1 at the Basin Creek Mine, is \$1,359,671.39. Table 6-8 presents the itemized capital costs and operation and maintenance costs associated with implementing this alternative.

Conceptual Design Assumptions

The following assumptions were used to develop costs directly and to calculate associated costs for this alternative:

- Access roads through the site would be improved to allow unobstructed access for heavy equipment. Any temporary roads constructed at the site would be obliterated and reclaimed after the field activities were completed.
- Approximately 8 acres would be prepared as part of construction activities. Preparation would include grubbing and installation of stormwater controls. Existing trees along the edge of the east arm would be left in place. Waste would be excavated around trees in such a manner as to minimize damage to the roots.

TABLE 6-8
COST ESTIMATE
ALTERNATIVE 5
OFF-SITE RELOCATION AT BASIN CREEK MINE LEACH PAD 1
SPRING MEADOW LAKE SITE

Cost Item	Quantity	Unit	Unit Cost (a)	Cost
Capital Costs				
Mobilization, Bonding & Insurance	1	LS	\$ 90,000.00	\$ 90,000.00
Site Preparation and Storm Water Control	8	Acre	\$ 1,000.00	\$ 8,000.00
Road Improvement	1	Mile	\$ 5,000.00	\$ 5,000.00
Waste Excavation and Loading	34,300	CY	\$ 2.00	\$ 68,600.00
Waste Transportation to LP 1	34,300	CY	\$ 20.00	\$ 686,000.00
Offsite Soil Borrow	17,200	CY	\$ 4.00	\$ 68,800.00
Cover Soil	5,600	CY	\$ 8.00	\$ 44,800.00
Fertilize, Seed, and Mulch	8	Acre	\$ 1,500.00	\$ 12,000.00
Cleanup and Demobilization	1	LS	\$ 10,000.00	\$ 10,000.00
Subtotal Construction Costs				\$ 993,200.00
Construction Contingencies	Percent of Construction Costs		15%	\$ 148,980.00
Engineering Design and Construction Oversight	Percent of Construction Costs =		15%	\$ 148,980.00
TOTAL CAPITAL COSTS				\$ 1,291,160.00
Yearly Operation and Maintenance (O&M) Costs				
Site Inspections	1	EA	\$ 500.00	500.00
Site Maintenance	Percent of Construction Costs =		0.5%	\$ 4,966.00
Subtotal O&M Costs				\$ 5,466.00
O&M Contingencies			1%	\$ 54.66
Total Yearly O&M Cost				\$ 5,520.66
Present Worth of O&M Costs Based on 30 Year Life at 7%		PW FACTOR =		12.41
TOTAL PRESENT WORTH				\$ 1,359,671.39

(a) Unit costs are based on recent bids for similar work at other Montana abandoned mine reclamation projects and professional judgment.

Notes:

LS = Lump Sum

CY = Cubic Yard

SY = Square Yard

LF = Lineal Feet

% = Percent

EA = Each

PW = Present Worth

- An estimated 34,300 cy (58,300 tons) of contaminated soil and mineral processing wastes would be excavated and hauled approximately 55 miles (one way) to LP1 via the town of Basin using highway haul trucks.
- Excavated areas at the East Arm area and Montana Wildlife Center (approximately 7 acres) would be backfilled with imported common borrow to approximately 50 percent of the total amount of removed material or 17,200 cy. Surfaces would be graded and blended to match existing contours and topography then covered with 6-inches of imported coversoil (5,600 cy). It is assumed that borrow soil and coversoil sources are located within a 5.0-mile radius of the site and would not require permitting.
- A total of 8 acres of disturbed ground, including excavated areas, staging areas and haul roads would be revegetated with plant species appropriate for the Spring Meadow Lake site.

6.5.7 Alternative 6: Excavation and Off-Site Disposal

Under this alternative, mineral processing wastes and contaminated soils at the Spring Meadow Lake site would be excavated and disposed of off-site at the city of Helena Landfill (Alternative 6a) or the Valley View Landfill near East Helena (Alternative 6b). The steps include the following: (1) improving access roads within the Spring Meadow Lake site; (2) excavating and hauling waste materials to the selected landfill; (3) backfilling, grading, and placing cover soil over the excavated areas; and (4) revegetating the disturbed areas at the site.

The disturbed areas would be prepared for revegetation, including the removal areas, staging areas and soil borrow areas. The excavated areas would be graded to match the contour of the land surface and, if necessary, cover soil would be applied to the disturbed areas.

Revegetation would likely take place during the fall of the year. The seed mixture and fertilizer would be simultaneously drilled into the prepared seed beds. Mulch would be applied to promote temporary protection of the disturbed erodible surfaces.

Heavy equipment would be required on site to implement this alternative efficiently. Multiple large-capacity haul trucks, bulldozers, front-end loaders, excavators, and compactors would be needed to excavate and haul the material.

Any saturated material excavated from Spring Meadow Lake would either be dried prior to being transported, or transported in covered trucks with lined, leak-proof beds.

6.5.7.1 Overall Protection of Human Health and the Environment

The implementation of this alternative would provide a means of reducing or eliminating the threat of direct contact with the waste material as well as reducing the risk of airborne exposure and soil ingestion. In addition, removing the wastes from the site and isolating the waste in a landfill would provide environmental protection by limiting the infiltration of precipitation and surface water that may leach contaminants to the groundwater.

The threat of direct human exposure would essentially be eliminated by this alternative. The potential for ingestion, dermal contact, and inhalation of soil containing arsenic and lead would be eliminated over the long term. Risks would be reduced to acceptable levels for recreational land uses. Due to the risk analysis being based on recreational use and to ensure that human health standards are not exceeded, future use of the land should be restricted to recreational uses.

Protection of the environment would be achieved under this alternative. Ecological exposures through all scenarios including deer exposure to lead through ingestion of surface salts, and plant phytotoxicity would also be reduced to acceptable levels or possibly eliminated.

6.5.7.2 Compliance with ARARS

There are no federal or state contaminant-specific ARARs that are required to be met for excavating and disposing of contaminated mineral processing wastes in an approved off-site landfill. However, removal of the specified waste and disposal in an off-site facility is expected to satisfy federal and state surface water and groundwater standards including MCL and HHS. The contaminants would not be expected to leach to surface water or groundwater because the primary waste sources of concern would be removed from the site.

Implementation of this alternative is expected to satisfy air quality regulations because the waste would be removed from the site.

OSHA requirements would be met by requiring appropriate safety training for all on-site workers during the construction phase of the project.

Location-specific ARARs are expected to be met without any conflicts. Contacts with appropriate agencies regarding wetlands, floodplains, and paleontological resources would be required.

All action-specific ARARs are anticipated to be met including the hydrological regulations contained in the Strip and Underground Mine Reclamation Act. The mining wastes were derived from the beneficiation and extraction of ores and are, therefore, assumed to be exempt from federal government regulation through RCRA as hazardous waste. In addition, revegetation requirements contained in the Surface Mining Control and Reclamation Act would be met. State of Montana dust suppression and control requirements are applicable for earth-moving activities associated with this alternative for the control of fugitive dust emissions; these requirements would be met through water application to roads receiving heavy vehicular traffic and to excavation areas, if necessary.

6.5.7.3 Long-Term Effectiveness and Permanence

This alternative achieves long-term risk reduction by transporting the contaminated mineral processing wastes to facilities that specialize in treatment, storage and disposal of nonhazardous wastes. Once materials from the Spring Meadow Lake site have been transported to a landfill, they may commingle with foreign materials.

Revegetation of the excavated areas would stabilize the land surface by providing erosion protection from surface water and wind erosion, and would reduce net infiltration through the media by increasing the evapotranspiration process. Determining the proper grading layout for the area after removal, selecting good quality soil cover, and selecting the appropriate plant species for revegetation would enhance the long-term effectiveness of this alternative. Long-term effectiveness would likely be improved by selecting site-adapted perennial plant species adapted to short growing seasons.

6.5.6.4 Reduction of Toxicity, Mobility or Volume through Treatment

The objective of this alternative is to provide a reduction in contaminant mobility although the waste is not treated. The volume or toxicity of the contaminants would not be physically reduced. Placing the mineral processing waste in a landfill would eliminate the solid media from the source area and reduce contaminant mobility through surface water and wind erosion. The source area of the contaminants would be reduced to an extent that would result in an overall risk reduction from all pathways and routes of exposure.

6.5.6.5 Short-Term Effectiveness

The construction phase of this alternative would likely be accomplished within one field season; therefore, impacts associated with removal would likely be short term and minimal. These potential short-term impacts would be mitigated during the removal phase. On-site workers would be adequately protected by using appropriate personal protective equipment and by following proper operating and safety procedures. However, short-term air and water quality impacts to the surrounding environment may occur due to waste excavation and regrading activities. Control of fugitive dust emissions would be accomplished by applying water to surfaces receiving heavy vehicular traffic or in excavation areas, as needed. A measurable short-term impact to the surrounding area would include increased vehicular traffic, particularly through the city of Helena, associated safety hazards, and potential dust generation in the vicinity of Spring Meadow Lake in association with construction. Activity associated with excavation is expected to impact use of the site as a recreational area. These impacts will be mitigated through the use of safety warnings and barriers and the use of water to control dust emissions.

6.5.6.6 Implementability

This alternative is technically feasible, and could be implemented within one field season. Excavation, transport, and disposal of contaminated soils are considered conventional construction practices; materials and construction methods are readily available. Excavation, transport, and disposal of materials are readily implementable and may be accomplished using local resources. Also, design methods and requirements are well documented and understood.

Components or factors which could potentially prolong the implementation of this alternative as planned include: (1) locating adequate earthen borrow and coversoil (or suitable plant-growth media) sources, (2) controlling fugitive dust emissions and storm water discharge during reclamation activities, (3) addressing landowner concerns, and (4) addressing concerns involving regular recreational use.

6.5.6.7 Costs

The estimated total present worth cost for Alternative 6, excavation and off-site disposal in a licensed landfill, is \$2,324,448.92 (Alternative 6a) or \$2,642,278.19 (Alternative 6b). Table 6-9 (Alternative 6a) and 6-10 (Alternative 6b) present the itemized capital costs and operation and maintenance costs associated with implementing this alternative.

TABLE 6-9
COST ESTIMATE
ALTERNATIVE 6a
OFF-SITE DISPOSAL AT THE CITY OF HELENA LANDFILL
SPRING MEADOW LAKE SITE

Cost Item	Quantity	Unit	Unit Cost (a)	Cost
Capital Costs				
Mobilization, Bonding & Insurance	1	LS	\$ 90,000.00	\$ 90,000.00
Site Preparation and Storm Water Control	8	Acre	\$ 1,000.00	\$ 8,000.00
Road Improvement	1	Mile	\$ 5,000.00	\$ 5,000.00
Waste Excavation and Loading	34,300	CY	\$ 2.00	\$ 68,600.00
Waste Transportation to the City Landfill	34,300	CY	\$.805	\$ 27,611.50
Landfill Tipping Fee	58,310	Ton	\$ 19.00	\$ 1,107,890.00
Offsite Soil Borrow	17,200	CY	\$ 4.00	\$ 68,800.00
Cover Soil	5,600	CY	\$ 8.00	\$ 44,800.00
Fertilize, Seed, and Mulch	8	Acre	\$ 1,500.00	\$ 12,000.00
Cleanup and Demobilization	1	LS	\$ 20,000.00	\$ 20,000.00
Subtotal Construction Costs				\$ 1,701,205.00
Construction Contingencies	Percent of Construction Costs		15 %	\$ 255,180.75
Engineering Design and Construction Oversight	Percent of Construction Costs		15 %	\$ 255,180.75
TOTAL CAPITAL COSTS				\$ 2,211,566.50
Yearly Operation and Maintenance (O&M) Costs				
Site Inspections	1	EA	\$ 500.00	500.00
Site Maintenance	Percent of Construction Costs		0.5 %	\$ 8,506.03
Subtotal O&M Costs				\$ 9,006.03
O&M Contingencies			1%	\$ 90.06
Total Yearly O&M Cost				\$ 9,096.09
Present Worth of O&M Costs Based on 30 Year Life at 7 %		PW FACTOR	12.41	\$ 112,882.42
TOTAL PRESENT WORTH				\$ 2,324,448.92

(a) Unit costs for disposal based on landfill quotes. Unit costs are based on recent bids for similar work at other Montana abandoned mine reclamation projects and professional judgment.

Notes:

LS = Lump Sum

CY = Cubic Yard

SY = Square Yard

LF = Lineal Feet

% = Percent

EA = Each

PW = Present Worth

TABLE 6-10
COST ESTIMATE
ALTERNATIVE 6b
OFF-SITE DISPOSAL AT VALLEY VIEW LANDFILL (EAST HELENA)
SPRING MEADOW LAKE SITE

Cost Item	Quantity	Unit	Unit Cost (a)	Cost
Capital Costs				
Mobilization, Bonding & Insurance	1	LS	\$ 90,000.00	\$ 90,000.00
Site Preparation and Storm Water Control	8	Acre	\$ 1,000.00	\$ 8,000.00
Road Improvement	1	Mile	\$ 5,000.00	\$ 5,000.00
Waste Excavation and Loading	34,300	CY	\$ 2.00	\$ 68,600.00
Waste Transportation to Valley View Landfill	34,300	CY	\$ 8.05	\$ 276,115.00
Landfill Tipping Fee	58,310	Ton	\$ 23.00	\$ 1,341,130.00
Offsite Soil Borrow	17,200	CY	\$ 4.00	\$ 68,800.00
Cover Soil	5,600	CY	\$ 8.00	\$ 44,800.00
Fertilize, Seed, and Mulch	8	Acre	\$ 1,500.00	\$ 12,000.00
Cleanup and Demobilization	1	LS	\$ 20,000.00	\$ 20,000.00
Subtotal Construction Costs				\$ 1,934,445.00
Construction Contingencies	Percent of Construction Costs =		15%	\$ 290,166.75
Engineering Design and Construction Oversight	Percent of Construction Costs =		15%	\$ 290,166.75
TOTAL CAPITAL COSTS				\$ 2,514,778.50
Yearly Operation and Maintenance (O&M) Costs				
Site Inspections	1	EA	\$ 500.00	500.00
Site Maintenance	Percent of Construction Costs =		0.5%	\$ 9,672.23
Subtotal O&M Costs				\$ 10,172.23
O&M Contingencies		1%		\$ 101.72
Total Yearly O&M Cost				\$ 10,273.95
Present Worth of O&M Costs Based on 30 Year Life @ 7%		PW FACTOR =	12.41	\$ 127,499.69
TOTAL PRESENT WORTH				\$ 2,642,278.19

(a) Unit costs for disposal based on landfill quotes. Unit costs are based on recent bids for similar work at other Montana abandoned mine reclamation projects and professional judgment.

Notes:

LS = Lump Sum

CY = Cubic Yard

LF = Lineal Feet

% = Percent

EA = Each

PW = Present Worth

Conceptual Design Assumptions

The following assumptions were used to develop costs directly and to calculate associated costs for these alternatives:

- Access roads through the site would be improved to allow unobstructed access for heavy equipment. Any temporary roads constructed at the site would be obliterated and reclaimed after the field activities were completed.
- Approximately 8 acres would be prepared as part of construction activities. Preparation would include grubbing and installation of stormwater controls. Existing trees along the edge of the east arm would be left in place. Waste would be excavated around trees in such a manner as to minimize damage to the roots.
- An estimated 34,300 cy (58,300 tons) of contaminated soil and mineral processing wastes would be excavated and hauled approximately 13 miles (one way) to either the city of Helena Landfill (Alternative 6a), or the Valley View Landfill (Alternative 6b).
- Excavated areas at the East Arm and Montana Wildlife Center (approximately 7 acres) would be backfilled with imported common borrow to approximately 50 percent of the total amount of removed material or 17,200 cy. Surfaces would be graded and blended to match existing contours and topography then covered with 6-inches of imported coversoil (5,600 cy). It is assumed that borrow soil and coversoil sources are located within a 5.0-mile radius of the site and would not require permitting.
- A total of 8 acres of disturbed ground, including excavated areas, staging areas and haul roads would be revegetated with plant species appropriate for the Spring Meadow Lake site.

6.6 COMPARATIVE ANALYSIS OF ALTERNATIVES

This section compares the reclamation alternatives retained for the Spring Meadow Lake site. The retained alternatives include: (1) Alternative 1 - No Action, (2) Alternative 2 - Institutional Controls, (3) Alternative 3 - Containment, (4) Alternative 4 - Excavation and On-Site Disposal in a Repository, (5) Alternative 5 - Excavation and Off-Site Relocation at Basin Creek Mine Leach Pad 1, and (6) Excavation and Off-site Disposal at a Solid Waste Landfill. The comparison focuses on the two threshold criteria (the relative protectiveness of human health and the environment and the estimated attainment of ARARs) and the primary balancing criteria. The following sections discuss the relative ability of each alternative to meet the threshold criteria.

6.6.1 Threshold Criteria

For the Spring Meadow Lake site, Alternatives 1, 2, 3, 4, 5, and 6 have all been retained. Baseline conditions at the site as represented by Alternative 1, the no action alternative, are not protective of human health and the environment. Alternative 2 would prevent land uses that result in exposures to site contaminants that lead to greater risk but would not reduce current risks and would still allow off-site migration of contaminants due to erosion. Therefore, Alternative 2 is not considered protective of human health and the environment.

Alternative 3 is considered protective of human health and the environment because installation of an earthen cap with liner geocomposite layer would isolate contaminated mineral processing wastes from contact with potential receptors, and it would reduce the potential for dust inhalation and off-site exposure via erosion. Alternatives 4, 5, and 6 are considered protective of human health and the environment because wastes would be effectively isolated either on-site or off-site.

Alternatives 3, 4, 5 and 6 would comply with ARARs by isolating the contaminated materials from contact with potential receptors, reducing releases to surface water, and reducing the potential for leaching of metals into groundwater. Chemical-specific ARARs may not be met under Alternative 2 because releases of site contaminants would remain unchanged.

Alternatives 1 and 2 are the least expensive as they have no (Alternative 1) or minimal (Alternative 2) costs associated with implementation. Alternative 3 (consolidation and combined geomembrane and earthen cover) has an estimated cost of \$820,991.97. Alternative 4 (on-site repository with geomembrane and earthen cap) has an estimated cost of \$950,320.28. Alternative 5 (off-site relocation at Leach Pad 1) has an estimated cost of \$1,359,671.39. Alternative 6a (off-site disposal at the city of Helena Landfill) and Alternative 6b (off-site disposal at the Valley View Landfill) have an estimated cost of \$2,324,448.92 and \$2,642,278.19 respectively. Table 6-11 summarizes the comparative analysis of these five alternatives.

TABLE 6-11
COMPARATIVE ANALYSIS OF ALTERNATIVES
SOLID MEDIA
SPRING MEADOW LAKE SITE

Assessment	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Criteria	No Action	Institutional Controls	Containment	Excavation and On-Site Disposal	Excavation and Off-Site Relocation at LPI	Excavation and Off-Site Disposal
Overall Protectiveness						
<i>Public Health, Safety, and Welfare</i>	No reduction in risk.	Human exposures expected to be reduced but not eliminated.	Exposures expected to be eliminated.	Exposures expected to be eliminated.	Exposures expected to be eliminated.	Exposures expected to be eliminated.
<i>Environmental Protectiveness</i>	No protection offered.	Ecological exposures expected to be reduced but not eliminated.	Exposures expected to be eliminated.	Exposures expected to be eliminated.	Exposures expected to be eliminated.	Exposures expected to be eliminated.
Compliance with ARARs						
<i>Chemical-Specific</i>	Some surface water standards currently exceeded.	Chemical-specific ARARs may not be met.	Chemical-specific ARARs would be met over long-term.	Chemical-specific ARARs would be met.	Chemical-specific ARARs would be met.	Chemical-specific ARARs would be met.
<i>Location-Specific</i>	None apply.	Location-specific ARARs would be met.	Location-specific ARARs would be met.	Location-specific ARARs would be met.	Location-specific ARARs would be met.	Location-specific ARARs would be met.
<i>Action-Specific</i>	None apply.	Action-specific ARARs would be met.	Action-specific ARARs would be met.	Action-specific ARARs would be met.	Action-specific ARARs would be met.	Action-specific ARARs would be met.
Long-Term Effectiveness and Permanence						
<i>Magnitude of Residual Risk</i>	No reduction in COC levels in any environmental media.	No reduction in COC levels in any environmental media, except by natural attenuation.	Contaminated materials remain on site. Significant risk reduction and greater reduction than Alternative 2.	Contaminated materials remain on site. Marginal reduction over Alternative 3.	Contaminated materials removed from site. Marginal additional reduction of Alternative 4.	Contaminated materials removed from site. Risk reduction similar to Alternative 5.
<i>Adequacy and Reliability of Controls</i>	No controls over any on-site contamination, no reliability.	Reliability of fence depends upon long-term maintenance. Erosion could cause off-site migration of COCs.	Reliability of caps dependent, in part, upon long-term maintenance.	Reliability of caps dependent, in part, upon long-term maintenance. More reliability than Alternative 3.	Wastes removed from site. Minimal site maintenance required. Similar reliability as Alternative 4.	Wastes removed from site. Minimal site maintenance required. Similar reliability as Alternatives 4 and 5.

TABLE 6-11 (Continued)
COMPARATIVE ANALYSIS OF ALTERNATIVES
SOLID MEDIA
SPRING MEADOW LAKE SITE

Assessment	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Criteria	No Action	Institutional Controls	Containment	Excavation and On-Site Disposal	Excavation and Off-Site Relocation at LPI	Excavation and On-Site Disposal
Reduction of Toxicity, Mobility, and Volume through Treatment						
<i>Treatment Process Used and Materials Treated</i>	None.	No treatment process.	No treatment process.	No treatment process.	No treatment process.	No treatment process.
<i>Volume of Contaminated Materials Treated</i>	None.	No treatment process.	No treatment process.	No treatment process.	No treatment process.	No treatment process.
<i>Expected Degree of Reduction</i>	None.	No treatment process.	No treatment process.	No treatment process.	No treatment process.	No treatment process.
Short-Term Effectiveness						
<i>Protection of Community During Reclamation Action</i>	Not applicable.	No site construction activities.	Fugitive emissions control may be required during construction.	Similar to Alternative 3.	More than Alternatives 3 and 4 due to significant truck hauling involved. Protection expected to be sufficient.	Similar to Alternative 5. Significant truck hauling involved. Protection expected to be sufficient.
<i>Protection of On-Site Workers During Removal Action</i>	Not applicable.	No site construction activities.	More construction hazards than Alternative 2. Protection expected to be sufficient.	Similar to Alternative 3.	More hazards than other alternatives due to significant truck hauling involved. Protection expected to be sufficient.	Similar to Alternative 5. Significant truck hauling involved. Protection expected to be sufficient.
<i>Time Until Removal Action Objectives are Achieved</i>	Not applicable.	One field season.	One field season.	One field season.	One field season.	One field season.

TABLE 6-11 (Continued)
COMPARATIVE ANALYSIS OF ALTERNATIVES
SOLID MEDIA
SPRING MEADOW LAKE SITE

Assessment	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Criteria	No Action	Institutional Controls	Containment	Excavation and On-Site Disposal	Excavation and Off-site Relocation at LPI	Excavation and Off-site Disposal
Implementability <i>Ability to Construct and Operate</i>						
	No construction or operation involved.	No difficulties anticipated.	Some difficulties expected with excavation in Spring Meadow Lake. Dewatering, surface water diversions possibly necessary.	Space available on site for repository. Otherwise similar to Alternative 3.	Sufficient repository space at the LPI repository. Otherwise similar to Alternative 4.	Some difficulties expected with excavation in Spring Meadow Lake. Dewatering, surface water diversions possibly necessary.
<i>Ease of Implementing More Action if Necessary</i>	Does not inhibit other actions from taking place at the site.	Easily implemented, if determined to be necessary (waste removal, stabilization, armoring, or other methods)	Waste materials located under earthen caps (or earthen caps with liners) not readily accessed without destroying caps.	Waste materials located within repository not readily accessed without destroying cap and liner. Other site activities outside of repository easily implemented such as additional armoring stabilization, or other methods.	Similar to Alternative 4.	Easily implemented such as waste removal, stabilization, armoring, or other methods.
<i>Availability of Services and Capacities</i>	Not applicable.	Available locally and within the state.	Available locally and within the state.	Available locally and within the state.	Available locally and within the state.	Available locally and within the state.
<i>Availability of Equipment and Materials</i>	Not applicable.	None Required	Available locally and within the state.	Available locally and within the state.	Available locally and within the state.	Available locally and within the state.
Cost						
ESTIMATED TOTAL PRESENT WORTH COST	\$0.00	\$11,267.05	\$820,991.97	\$950,320.28	\$1,359,671.39	\$2,324,448.92 (6a)
						\$2,642,278.19 (6b)

6.6.2 Summary

Alternatives 4, 5, and 6 provide the greatest protection of human health and the environment, compliance with ARARs, long-term effectiveness, reduction in mobility, and short-term effectiveness.

Implementability of Alternative 4 depends upon sufficient space being available at the Spring Meadow Lake site for construction of the proposed repository with a minimum capacity of 34,300 cy.

Implementability of Alternative 5 also depends upon the availability of Leach Pad 1 at the Basin Creek Mine. Alternative 5 is about 43 percent more expensive than Alternative 4; most of this additional cost is associated with waste hauling. Alternative 6a is about 145 percent more expensive than Alternative 4 and 71 percent more expensive than Alternative 5. Alternative 6b is the most expensive alternative and is about 178 percent more expensive than Alternative 4 and 94 percent more expensive than Alternative 5. Most of the additional costs for Alternative 6 are associated with the landfill tipping fees.

Alternative 3 also provide protection of human health and the environment, compliance with ARARs, short-term effectiveness, and implementability. Long-term effectiveness of Alternative 3 is considered to be less than Alternatives 4, 5, and 6 because the waste is remains on site and does not have the additional containment afforded by a bottom liner. Alternative 3 is about 14 percent less costly than Alternative 4, about 40 percent less costly than Alternative 5, about 65 percent less costly than Alternative 6a, and about 69 percent less costly than Alternative 6b.

Alternative 2 would not provide overall protection of human health and the environment because off-site releases of contaminants through air, surface water, and groundwater would continue.

6.6.3 Preferred Reclamation Alternative

A preferred alternative will be selected after appropriate agencies have reviewed the presented alternatives and public feedback has been received and considered.

6.7 REFERENCE CITED

U.S. Environmental Protection Agency (EPA). 1988. "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCA)." U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, D.C.

APPENDIX 6-A

**FEDERAL
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS**

**APPENDIX 6-A — FEDERAL ARARs
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1.0 INTRODUCTION

DEQ/MWCB has provided a document describing ARARs for reclamation of abandoned mine sites. The federal ARARs, advisories, and guidance for reclaiming the Spring Meadow Lake site are presented below.

2.0 FEDERAL CONTAMINANT-SPECIFIC ARARS

2.1 CLEAN AIR ACT (APPLICABLE)

Section 109 of the Clean Air Act (42 USC § 7409) and implementing regulations found in 40 CFR Part 50 set national primary and secondary ambient air quality standards. National primary ambient air quality standards define levels of air quality that are necessary, with an adequate margin of safety, to protect the public health. National secondary ambient air quality standards define levels of air quality that are necessary to protect public welfare from any known or anticipated adverse effects of a pollutant. The standards for particulate matter in 40 CFR § 50.6 are applicable for reclamation alternatives for the Spring Meadow Lake site, particularly for the excavation, earth moving, regrading, and potential transport of the fine-grained materials. These standards must be met both during the design and implementation phases of the reclamation activities.

Particulate Matter

The ambient air quality standard for particulate matter of less than or equal to 10 micrometers in diameter (PM-10) is 150 micrograms per cubic meter, 24-hour average concentration; 50 micrograms per cubic meter, annual arithmetic mean for particulate matter of less than or equal to 10 micrometers in diameter.

In addition, state law provides an ambient air quality standard for settled particulate matter. Particulate matter concentrations in the ambient air shall not exceed the 30-day average: 10 grams per square meter. Administrative Record of Montana (ARM) § 16.8.818 (applicable).

2.2 RESOURCE CONSERVATION AND RECOVERY ACT (APPLICABLE)

Under 40 CFR Part 261, Subpart D, defines the solid wastes (mining-related wastes) which are subject to regulations as hazardous wastes. This requirement is applicable to reclamation alternatives at the Spring Meadow Lake site that involve the treatment, storage, or disposal of hazardous wastes in a solid waste management unit (such as a surface impoundment, waste pile, land treatment unit, or landfill). The limits specified for groundwater protection are the same as the maximum contaminant levels (MCL) for those substances as defined in Section 2.4.

2.3 CLEAN WATER ACT (RELEVANT AND APPROPRIATE)

The Federal Clean Water Act (33 USC §§ 1387) as amended by the Water Quality Act of 1987 (Public Law 100-4 § 103) provides the authority for each state to adopt water quality standards (40 CFR Part 131) designed to protect beneficial uses of each water body and requires each state to designate uses for each water body. EPA regulations require states to establish antidegradation requirements. EPA has provided guidance to the states for this purpose ("Water Quality Criteria Summary"; Quality Criteria for Water 1986 - Update 2 EPA; May 1, 1987).

At this time, EPA is relying on the State standards. EPA reserves the right to identify federal water quality criteria as ARARs for this action, if appropriate.

40 CFR Part 122 establishes the National Pollutant Discharge Elimination System (NPDES). The substantive requirements of general permits for storm water discharges from construction are relevant and appropriate. See 57 Fed. Reg. 41236, September 9, 1992. Montana has an EPF-approved State program (MPDES) that is discussed in the State ARARs section.

2.4 SAFE DRINKING WATER ACT (RELEVANT AND APPROPRIATE)

The Safe Drinking Water Act (SDWA) has established the maximum contaminant levels (MCL) for chemicals in drinking water distributed in public water systems. SDWA MCLs are not applicable to the reclamation activities at the site because the groundwater and surface water at the site are not a public water supply. The SDWA MCLs are relevant and appropriate at the Spring Meadow Lake site even though the groundwater and surface water are not currently part of a public water system. The Preamble to the National Oil and Hazardous Substance Contingency Plan (NCP) clearly states that the MCLs are

relevant and appropriate for groundwater that is a current or potential source of drinking water (55 Fed. Reg. 8750 [March 8, 1990]) and is further supported by requirements of the NCP, 40 CFR § 300.430(e)(2)(i)(B). MCLs developed under the SDWA generally are ARARs for current or potential drinking water sources.

Standards for potential contaminants of concern at the Spring Meadow Lake site are:

<u>Chemical</u>	<u>MCLs</u>	<u>Human Health Standards^a</u>
Antimony	6 (µg/L)	6 (µg/L)
Arsenic	10 (µg/L)	18 (µg/L)
Cadmium	5 (µg/L)	5 (µg/L)
Copper	1,300 ^b (µg/L)	1,300 (µg/L)
Chromium (Total)	100 (µg/L)	100 (µg/L)
Cyanide	200 (µg/L)	200 (µg/L)
Lead	15 ^b (µg/L)	15 (µg/L)
Mercury	2 (µg/L)	0.05 (µg/L)

Note:

a = DEQ Circular WQB-7 (January 2004)

b = Action level, not an MCL

The EPA has granted to the State of Montana primacy in the enforcement of the SDWA. Thus, the law commonly enforced in Montana is the state law. The state regulations substantially parallel the federal law.

3.0 FEDERAL LOCATION-SPECIFIC ARARS

3.1 NATIONAL HISTORIC PRESERVATION ACT (APPLICABLE)

This statute and implementing regulations (16 USC § 470, 36 CFR Part 800, 40 CFR 6.310[b]), require federal agencies or federal projects to take into account the effect of any federally assisted undertaking or licensing on any district, site, building, structure, or object that is included in, or eligible for, the Register of Historic Places. Compliance with this ARAR requires consultation with the State Historic Preservation Officer (SHPO), who can identify historic properties and assess whether proposed clean-up actions at the Spring Meadow Lake site will impact these resources.

3.2 ARCHEOLOGICAL AND HISTORICAL PRESERVATION ACT (APPLICABLE)

This statute and implementing regulations (16 USC § 469, 40 CFR § 6.301[c]) establish requirements for the evaluation and preservation of historical and archaeological data, which may be destroyed through alteration of terrain as a result of a federal construction project or a federally licensed activity or program. This requires a survey of the site for covered scientific, prehistorical or archaeological artifacts. Preservation of appropriate data concerning the artifacts is hereby identified as an ARAR requirement, to be completed at the Spring Meadow Lake site during the implementation of the reclamation activities.

3.3 HISTORIC SITES, BUILDINGS AND ANTIQUITIES ACT (APPLICABLE)

This Act (16 USC §§ 461 et seq.; 40 CFR § 6.301[a]) states that "[i]n conducting an environmental review of a proposed EPA action, the responsible official shall consider the existence and location of natural landmarks using information provided by the National Park Service pursuant to 36 CFR § 62.6(d) to avoid undesirable impacts upon such landmarks." "National natural landmarks" are defined under 36 CFR § 62.2 as:

Area(s) of national significance located within [the U.S.] that contain(s) an outstanding representative example(s) of the nation's natural heritage, including terrestrial communities, aquatic communities, landforms, geological features, habitats of natural plant and animal species, or fossil evidence of development of life on earth.

Under the Historic Sites Act of 1935, the Secretary of the Interior is authorized to designate areas as National Natural Landmarks for listing on the National Registry of Natural Landmarks. A survey has been conducted at the Spring Meadow Lake site in order to determine whether potential natural landmarks are present.

3.4 PROTECTION OF WETLANDS ORDER (APPLICABLE)

This requirement (40 CFR Part 6, Appendix A, Executive Order No. 11990) mandates Federal agencies and the potentially responsible party (PRP) to avoid, to the extent possible, the adverse impacts associated with the destruction or loss of wetlands and to avoid support of new construction in wetlands if a practicable alternative exists. For this project, jurisdictional wetland identification has not been performed; however, wetlands are not likely to exist on the Spring Meadow Lake site. Compliance with this ARAR requires consultation with the U.S. Army Corps of Engineers and the U.S. Fish and Wildlife

Service to determine the presence and extent of wetlands and to ascertain the means and measures necessary to mitigate, prevent, and compensate for project related losses of wetlands.

3.5 ENDANGERED SPECIES ACT (APPLICABLE)

This statute, and implementing regulations (16 USC §§ 1531-1543, 50 CFR § 402, and 40 CFR § 6.302[h]), require that any federal activity or federally authorized activity may not jeopardize the continued existence of any threatened or endangered species or destroy or adversely modify critical habitat.

Compliance with this requirement involves consultation with the U.S. Fish and Wildlife Service, resulting in a determination as to whether there are listed or proposed species or critical habitats present at the Spring Meadow Lake site, and, if so, whether any proposed activities will impact such wildlife or habitat. At this time no threatened or endangered species or critical habitat has been identified on the site.

3.6 RESOURCE CONSERVATION AND RECOVERY ACT (APPLICABLE)

The requirements set forth at 40 CFR § 264.18(a) and (b) provide that: a) any hazardous waste facility must not be located within 61 meters (200 feet) of a fault; and b) any hazardous waste facility within the 100-year floodplain must be designed, constructed, operated, and maintained to avoid washout. Any discrete disposal or storage facilities, which remain on site as part of reclamation alternatives at the Spring Meadow Lake site must meet these standards.

4.0 FEDERAL ACTION-SPECIFIC ARARS

4.1 HAZARDOUS MATERIALS TRANSPORTATION ACT (APPLICABLE)

The Hazardous Materials Transportation Act (49 USC §§ 1801-1813), as implemented by the Hazardous Materials Regulations (49 CFR Parts 10, 171-177), regulates the transportation of hazardous materials. The regulations may be applicable to reclamation alternatives at the Spring Meadow Lake site, if non-exempt (Bevill) hazardous mining waste is transported off site, via public highways on site, or by rail.

4.2 RESOURCE CONSERVATION AND RECOVERY ACT

Criteria for Classification of Solid Waste Disposal Facilities Practices (Applicable)

The criteria contained in 40 CFR Part 257 (Subtitle D) are used in accordance with RCRA guidance in determining which practices pose a reasonable probability of having an adverse effect on human health or the environment. RCRA Subtitle D establishes criteria which are, for the most part, environmental performance standards that are used by states to identify unacceptable solid waste disposal practices or facilities.

Regulation 40 CFR Part 257.3-2 provides for the protection of threatened or endangered species.

Regulation 40 CFR Part 257.3-3 provides that the facility shall not cause the discharge of pollutants into waters of the United States; this includes dredged or fill materials.

Regulation 40 CFR Part 257.3-4 states that a facility or practice shall not contaminate underground drinking water beyond the solid waste boundary.

Standards Applicable to Transporters of Hazardous Waste (Applicable)

The regulations in 40 CFR Part 263 establish standards that apply to persons that transport hazardous waste within the U.S. If any hazardous waste is transported from the Spring Meadow Lake site via rail-line or public highway, these regulations will be applicable.

Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities (Applicable)

The regulations in 40 CFR Part 264 establishes minimum national standards which define the acceptable management of hazardous waste for owners and operators of facilities which treat, store, or dispose of hazardous waste. These standards could be applicable to reclamation alternatives at the Spring Meadow Lake site that incorporate the treatment, storage or disposal of hazardous waste on site.

A. Releases from Solid Waste Management Units

The regulations in 40 CFR 264, Subpart F, establish requirements for groundwater protection for RCRA-regulated solid waste management units (such as waste piles, land treatment units, and landfills). Subpart F provides for three general types of groundwater monitoring: detection monitoring, compliance monitoring, and corrective action monitoring. Monitoring is required during the active life of a hazardous waste management unit.

B. Closure and Post-Closure

40 CFR Part 264, Subpart G, establishes that hazardous waste management facilities must be closed in such a manner as to: a) minimize the need for further maintenance; and b) control, minimize or eliminate, to the extent necessary, to protect public health and the environment, post-closure escape of hazardous wastes, hazardous constituents, leachate, contaminated runoff or hazardous waste decomposition products to the ground or surface waters or to the atmosphere.

C. Waste Piles

Regulation 40 CFR Part 264, Subpart L, applies to owners and operators of facilities that store or treat hazardous waste in piles.

D. Land Treatment

The requirements of 40 CFR Part 264, Subpart M, regulate the management of "land treatment units" that treat or dispose of hazardous waste; these requirements would be relevant and appropriate for any land treatment units established at the site.

E. Landfills

Regulation 40 CFR Part 264, Subpart N, applies to entities that dispose of hazardous waste in landfills. The regulations specify appropriate liner systems and leachate collection systems for landfills, run-on and run-off management systems, and wind dispersal controls for landfills. These regulations set forth specific requirements for landfill monitoring and inspection, surveying and recordkeeping, and closure and post-closure care.

4.3 CLEAN WATER ACT (RELEVANT AND APPROPRIATE)

33 USC 1251 Section 404 establishes requirements to regulate the discharge of dredged and fill materials into waters of the United States. The substantive requirements of general permits or individual permits for construction activities that may compromise water quality are relevant and appropriate.

40 CFR Part 122 establishes the NPDES. The substantive requirements of general permits for storm water discharges from construction are relevant and appropriate. See 57 Fed. Reg. 41236, September 9, 1992. Montana has an EPA-approved State MPDES that is discussed in the State ARARs section.

4.4 SURFACE MINING CONTROL AND RECLAMATION ACT (RELEVANT AND APPROPRIATE)

This Act (30 USC §§ 1201-1326) and implementing regulations found at 30 CFR Parts 816 and 784 establish provisions designed to protect the environment from the effects of surface coal mining operations, and to a lesser extent, non-coal mining. These regulations require that revegetation be used to stabilize soil covers over reclaimed areas. The reclamation performance standards are relevant and appropriate to reclaimed mine sites.

APPENDIX 6-B

**STATE OF MONTANA
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS**

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1.0 INTRODUCTION

DEQ/MWCB has provided a draft document describing ARARs for abandoned mine sites. State of Montana ARARs specific to the Spring Meadow Lake site are presented below.

2.0 MONTANA CONTAMINANT-SPECIFIC ARARs

2.1 MONTANA WATER QUALITY ACT (APPLICABLE)

Under the state Water Quality Act, §§ 75-5-101 et seq., MCA, and ARM 17.30.601 et seq., the legislature has promulgated regulations to preserve and protect the quality of surface waters in the state. These regulations classify state waters according to quality, place restrictions on the discharge of pollutants to state waters, and prohibit the degradation of state waters. The requirements listed below are applicable water quality standards with which any reclamation activity must comply.

Surface Water Quality Standards and Procedures (Applicable)

ARM 17.30.637 (Applicable), which prohibits discharges containing substances that will:

- (a) settle to form objectionable sludge deposits or emulsions beneath the surface of the water or upon adjoining shorelines;
- (b) create floating debris, scum, a visible oil film (or be present in concentrations at or in excess of 10 milligrams per liter) or globules of grease or other floating materials;
- (c) produce odors, colors or other conditions which create a nuisance or render undesirable tastes to fish flesh or make fish inedible;
- (d) create concentrations or combinations of materials which are toxic or harmful to human, animal, plant or aquatic life;
- (e) create conditions which produce undesirable aquatic life.

ARM 17.30.637 also provides that leaching pads, tailing ponds, or water, waste, or product holding facilities must be located, constructed, operated and maintained to prevent any discharge, seepage, drainage, infiltration, or flow which may result in pollution of state waters, and a monitoring system may be required to ensure such compliance. No pollutants may be discharged and no activities may be conducted which, either alone or in combination with other wastes or activities, result in the total dissolved gas pressure relative to the water surface exceeding 110 percent of saturation.

Reclamation alternatives for the Spring Meadow Lake site should be evaluated with respect to the "prohibitions" set out in 17.30.637.

Montana Groundwater Pollution Control System (Applicable)

ARM 17.30.1006 (Applicable) classifies groundwater into Classes I through IV based upon its specific conductance and establishes the groundwater quality standards applicable with respect to each groundwater Classification.

If determined to be Classes I through III groundwater based on its specific conductance, the groundwater at the site must meet the beneficial uses and standards for that class. Concentrations of substances in groundwater within these classes may not exceed the human health standards for groundwater listed in department Circular WQB-7. In addition, no increase of a parameter may cause a violation of § 75-5-303 MCA, (nondegradation). For concentrations of parameters for which human health standards are not listed in WQB-7, ARM 17.30.1006 allows no increase of a parameter to a level that renders the waters harmful, detrimental or injurious to the beneficial uses listed for that class of water. For standards for Class IV groundwater, see ARM 17.30.1006.

ARM 17.30.1011 (Applicable) provides that any groundwater whose existing quality is higher than the standard for its classification must be maintained at that high quality unless the requirements of 75-5-303(3) MCA are met.

2.2 CLEAN AIR ACT (APPLICABLE)

Air quality regulations pursuant to the Act, §§ 75-2-101 et seq., MCA, are discussed below.

ARM 17.8.206 (Applicable) establishes sampling, data collection, recording, analysis, and transmittal requirements to ensure compliance with ambient air quality standards.

ARM 17.8.220 (Applicable) specifies that no person shall cause or contribute to concentrations of particulate matter in the ambient air such that the mass of settled particulate matter exceeds the following 30-day average: 10 grams per square meter, 30-day average, not to be exceeded.

ARM 17.8.222 (Applicable) specifies that no person shall cause or contribute to concentrations of lead in the ambient air which exceed the following: 90-day average--1.5 micrograms per cubic meter of air, 90-day average, not to be exceeded.

ARM 17.8.223 (Applicable) specifies that no person may cause or contribute to concentrations of PM-10 in the ambient air which exceed the following standard:

1. 24-hour average: 150 micrograms per cubic meter of air 24 hour average, with no more than 1 exceedence per year expected.
2. Annual average: 50 micrograms per cubic meter of air, expected annual average, not to be exceeded.

ARM 17.8.210-214 (Applicable) describes ambient air standards that are promulgated for carbon monoxide, hydrogen sulfide, nitrogen dioxide, sulfur dioxide, and ozone. If emissions of these compounds were to occur at the site in connection with any response action, these standards would be applicable.

3.0 MONTANA LOCATION-SPECIFIC ARARS

3.1 ENDANGERED SPECIES ACT (APPLICABLE)

Sections 87-5-106, 107, 111, and 201, MCA describe nongame wildlife in need of management that should be protected in order to maintain and, to the extent possible, enhance their numbers. These sections identify prohibited acts, and penalties.

ARM 12.5.201 (Applicable) lists specified endangered species.

3.2 FLOODPLAIN AND FLOODWAY MANAGEMENT ACT (RELEVANT AND APPROPRIATE)

Section 76-5-401, MCA, and ARM 36.15.601, 602, 603, and 604 (Relevant and Appropriate) specifies types of uses and structures that are allowed without permits, allowed with permits, or prohibited in the designated 100-year floodway and floodplain. Uses prohibited anywhere in either the floodway or the floodplain include, but are not limited to: (1) solid and hazardous waste disposal; and (2) storage of toxic, flammable, hazardous, or explosive materials.

Section 76-5-402, MCA, (Relevant and Appropriate) specifies factors that must be considered in allowing diversions of the stream, changes in place of diversion of the stream, flood control works, new construction or alteration of artificial obstructions, or any other nonconforming use within the floodplain or floodway.

Floodplain Management Regulations (Relevant and Appropriate)

ARM 36.15.605, 36.15.703, and 36.15.602(5)(b) (Relevant and Appropriate) effectively prohibit the placement of mine waste repositories within the 100-year floodplain and require that mine wastes be stockpiled outside the floodway. In the floodway, additional provisions apply, including prohibition of: (1) a building for living purposes or place of assembly or permanent use by human beings; (2) any structure or excavation that will cause water to be diverted from the established floodway, cause erosion, obstruct the natural flow of water, or reduce the carrying capacity of the floodway; and (3) the construction or permanent storage of an object subject to flotation or movement during flood level periods.

For the substantive conditions and restrictions applicable to specific obstructions or uses, see the following applicable regulations:

- Excavation of material from pits or pools – ARM 36.15.602(1)
- Water diversions or changes in place of diversion – ARM 36.15.603
- Flood control works (levees, floodwalls, and riprap must comply with specified safety standards) – ARM 36.15.606
- Road, streets, highways and rail lines (must be designed to minimize increases in flood heights) – ARM 36.15.701(3)(c).
- Structures and facilities for liquid or solid waste treatment and disposal (must be floodproofed to ensure that no pollutants enter flood waters and must be allowed and approved only in accordance with DEQ regulations, ARM 36.15.701(3)(d).
- Residential structures – ARM 36.15.702(1)
- Commercial or industrial structures – ARM 36.15.702(2)

3.3 SOLID WASTE MANAGEMENT ACT (APPLICABLE)

Several regulations promulgated under the Solid Waste Management Act, §§ 75-10-201 et seq., MCA, specify requirements that apply to location of any solid waste management facility.

Solid Waste Management Regulations (Applicable)

ARM 17.50.505 (Applicable) provides that a facility for the treatment, storage or disposal of solid wastes: (1) must be located where sufficient acreage of suitable land is available for solid waste management; (2) may not be located in a 100-year floodplain; (3) may be located only in areas which will prevent the pollution of ground and surface waters and public and private water supply systems; (4) must be located to allow for reclamation and reuse of the land; (5) drainage structures must be installed where necessary to prevent surface runoff from entering waste management areas; and (6) where underlying geological formations contain rock fractures or fissures which may lead to pollution of the ground water or areas in which springs exist that are hydraulically connect to a proposed disposal facility, only Class III disposal facilities (those containing completely inert wastes) may be approved.

4.0 MONTANA ACTION-SPECIFIC ARARS

4.1 GROUNDWATER ACT (APPLICABLE)

Section 85-2-505, MCA prohibits the wasting of groundwater. Any well producing waters that contaminate other waters must be plugged or capped, and wells must be constructed and maintained so as to prevent waste, contamination, or pollution of groundwater.

Section 85-2-516, MCA states that within 60 days after any well is completed, a well log report must be filed by the driller with the Bureau of Mines and Geology.

ARM 17.30.641 (Applicable) provides methods for sampling and analysis of water to determine quality.

ARM 17.30.646 (Applicable) requires that bioassay tolerance concentrations be determined in a manner specified in the regulation.

ARM 36.21.670-678 and 810 (applicable) specifies requirements for abandoning groundwater monitoring wells.

4.2 WATER QUALITY ACT (APPLICABLE)

Section 75-5-605, MCA, makes it unlawful to cause pollution of any State waters or to place or cause to be placed any wastes in a location where they are likely to cause pollution of any State waters.

Montana Pollutant Discharge Elimination System (MPDES) (Applicable)

The MPDES standards are set out in 17.30.1201, et seq.

ARM 17.30.1203 (Applicable) adopts and incorporates the provisions of 40 CFR Part 125 for criteria and standards for the imposition of technology-based treatment requirements in MPDES permits. Although the permit requirement would not apply to on-site discharges, the substantive requirements of Part 125 are applicable, that is, for toxic and nonconventional pollutants treatment must apply the best available technology economically achievable (BAT); for conventional pollutants, application of the best conventional pollutant control technology (BCT) is required. Where effluent limitations are not specified for the particular industry or industrial category at issue, BCT/BAT technology-based treatment requirements are determined on a case-by-case basis using best professional judgment (BPJ). See CERCLA Compliance with Other Laws Manual, Vol. I, August 1988, p. 3-4 and 3-7.

ARM 17.30.1342-1344 (Applicable) Sets the substantive requirements for all MPDES and NPDES permits, including the requirement to properly operate and maintain all facilities and systems of treatment and control.

Nondegradation of Water Quality (Applicable)

The Water Quality Act and regulations also include nondegradation provisions which require that waters which are of higher quality than the applicable classification be maintained at that high quality, and discharges which would degrade that water are prohibited. Montana's standard for nondegradation of water quality is applicable for all constituents for which pertinent portions of affected surface waters are of higher quality than the I classification. If any reclamation activity constitutes a new source of pollution or an increased source of pollution, the nondegradation standard requires the degree of waste treatment necessary to maintain the existing water quality for constituents that are of higher quality than the applicable classification.

ARM 17.30.705 (Applicable) applies nondegradation requirements to any activity of man which would cause a new or increased source of pollution to state waters. This section indicates when exceptions to nondegradation requirements apply, except that in no event may such degradation affect public health, recreation, safety, welfare, livestock, wild birds, fish and other wildlife or other beneficial uses.

ARM 17.30.1011 (Applicable) provides that any groundwater whose existing quality is higher than the standard for its classification must be maintained at that high quality unless degradation is allowed under ARM 17.30.701 et. seq.

Storm Water Runoff (Applicable)

ARM 17.30.1341(i) (Applicable) requires a Storm Water Discharge General Permit for storm water point sources. Generally, the permits require the permittee to implement Best Management Practices (BMP) and to take all reasonable steps to minimize or prevent any discharge which has a reasonable likelihood of adversely affecting human health and the environment. However, if there is evidence indicating potential or realized impacts on water quality due to any storm water discharge associated with the activity, additional protection may be required.

ARM 17.24.633 (Applicable) states that all surface drainage from a disturbed area must be treated by the best technology currently available..

4.3 HAZARDOUS WASTE MANAGEMENT ACT (APPLICABLE)

Section 75-10-401, MCA, et seq. and ARM Title 17, Chapter 54 establishes requirements for the generation, transportation, treatment, storage, and disposal of hazardous wastes.

4.4 SOLID WASTE MANAGEMENT ACT (APPLICABLE OR RELEVANT AND APPROPRIATE)

Several regulations promulgated under the Solid Waste Management Act, §§ 75-10-201 et seq., MCA, are discussed in the federal section of ARARs, because the state implements that federal program.

Solid Waste Management Regulations (Applicable)

ARM 17.50.505 (Applicable) sets forth standards that all solid waste disposal sites must meet.

ARM 16.14.506 (Applicable) specifies design requirements for landfills.

ARM 17.50.511 (Applicable) set forth the general and specific operation and maintenance and design requirements for solid waste management systems.

ARM 17.50.523 (Applicable) specifies that solid waste must be transported in such a manner as to prevent its discharge, dumping, spilling or leaking from the transport vehicle.

ARM 17.50.530 (Applicable) sets forth the closure requirements for landfills.

ARM 17.50.531 (Applicable) sets forth post closure care requirements for Class II landfills.

Section 75-10-206, MCA allows variances to be granted from certain solid waste regulations if failure to comply with the rules does not result in danger to public health and safety or compliance with specific rules would produce hardship without producing benefits to the health and safety of the public that outweigh the hardship.

4.5 MONTANA STRIP AND UNDERGROUND MINE RECLAMATION ACT, MONTANA METAL MINING ACT, AND MONTANA METAL MINE RECLAMATION ACT (RELEVANT AND APPROPRIATE)

The Spring Meadow Lake site is a foundry/mill site. Regulations promulgated under Montana's Strip and Underground Mine Reclamation Act, §§ 82-4-201 et seq., MCA, Metal Mining Act, §§ 82-4-301 et seq., and Metal Mine Reclamation Act, §§ 82-4-336 provide detailed guidelines for addressing the impacts of mine reclamation activities and earth moving projects and may be relevant and appropriate for addressing these impacts in MWCB reclamation projects.

- §§ 82-4-231, MCA - Requires operators to reclaim and revegetate affected lands. Operators must grade, backfill, topsoil, reduce high walls, stabilize subsidence, control water, and minimize erosion, subsidence, landslides, and water pollution.
- §§ 82-4-233, MCA - Operators must plant vegetation that will yield a diverse, effective, and permanent vegetative cover of the same seasonal variety native to the area and capable of self-generation..
- ARM 17.24.501(3)(a) and (b) and (4) - Backfill must be placed so as to minimize sedimentation, erosion, and leaching of acid or toxic materials into waters as, approved by DEQ.
- ARM 17.24.519 - Regraded areas may be monitored for settling. Results may be used to alter reclamation techniques

- ARM 17.24.631(1), (2), (3)(a), and (b) - Disturbances to the prevailing hydrologic balance will be minimized. Changes in water quality and quantity, in the depth to groundwater and in the location of surface water drainage channels will be minimized. Pollution minimization and prevention measures must be used including stabilizing disturbed areas through land shaping, diverting runoff, planting quickly germinating and growing stands of temporary vegetation, regulating velocity of water, lining drainage channels with rock or vegetation, mulching, and control of acid-forming, and toxic-forming waste materials.
- ARM 17.24.633 - Surface drainage from a disturbed area must be treated by the best technology currently available (BCTA), before leaving the permit area.
- ARM 17.24.634 - Disturbed drainage basins will be constructed in conformity with the requirements set out in the regulations.
- ARM 17.24.635-637 - Sets forth requirements for permanent diversions.
- ARM 17.24.638 - Sediment control measures must designed, constructed and maintained as set out in this regulation.
- ARM 17.24.639 - Sets forth location requirements for construction and maintenance of sedimentation ponds.
- ARM 17.24.640 - Discharges from sedimentation ponds, diversions, and impoundments must be controlled to reduce erosion and enlargement of stream channels, and to minimize disturbance of the hydrologic balance.
- ARM 17.24.641 – Sets out practices required to prevent drainage of acid or toxic forming spoil material into ground and surface water.
- ARM 17.24.643-646 - Establishes provisions for surface water monitoring.
- ARM 17.24.701-703 – Establishes requirements for removal, redistributing, handling and stockpiling of soil for reclamation.
- ARM 17.24.711 - Requires that a diverse, effective and permanent vegetative cover of the same seasonal variety and utility as the vegetation native to the area of land to be affected must be established.
- ARM 17.24.713 - Seeding and planting of disturbed areas must be conducted during the first appropriate period for favorable planting after final seedbed preparation.
- ARM 17.24.714 – Practices such as mulch and cover crop must be used until adequate permanent cover can be established.
- ARM 17.24.716 - Methods of revegetation must be approved by DEQ.
- ARM 17.24.717 - The planting of trees or shrubs must be approved by DEQ.

- ARM 17.24.718 - Soil amendments must be used as necessary to establish a permanent vegetative cover.
- ARM 17.24.721 - Specifies conditions under which rills or gullies must be stabilized.
- ARM 17.24.723 - States that operators shall conduct periodic monitoring of vegetation, soils, and wildlife to demonstrate compliance.
- ARM 17.24.724 - Specifies that revegetation success must be measured by comparison with approved unmined reference areas or technical standards.
- ARM 17.24.726 - Sets the required methods for measuring and evaluating vegetation data.
- ARM 17.24.731 - Provides that for the revegetated area and the reference area the DEQ may require comparative chemical analyses.
- ARM 17.24.751 – Establishes requirement to prevent jeopardy of threatened or endangered species and establishes requirements regarding powerlines, roads, and structures for protection of wildlife.
- ARM 17.24.761 - Specifies fugitive dust control measures which will be employed during excavation and construction activities to minimize the emission of fugitive dust.

4.6 CLEAN AIR ACT (APPLICABLE)

Air Quality Regulations (Applicable)

Dust suppression and other similar actions may be necessary to control the release of substances into the air as a result of excavation, earth moving, regrading, and potential transport of mine wastes both off- and on-site. The ambient air standards for specific contaminants and for particulates are set forth in the federal contaminant-specific section above. The levels of certain substances that may not be exceeded are identified in the Air Quality section of the contaminant-specific state ARARs. Additional air quality regulations under the state Clean Air Act, §§ 75-2-101 et seq., MCA, are discussed below.

ARM 17.8.304 (2) (Applicable) specifies that visible air contaminant emissions into the outdoor atmosphere from a source installed before 12/23/68 shall not exhibit an opacity of 40 percent or greater averaged over six consecutive minutes.

ARM 17.8.308(4) (Applicable) requires that any new source of airborne particulate matter that has the potential to emit less than 100 tons per year of particulates shall apply best available control technology

(BACT); any new source of airborne particulate matter that has the potential to emit more than 100 tons per year of particulates shall apply lowest achievable emission rate (LAER).

ARM 17.8.308 (2), (3), (Applicable) specifies that there shall be no production, handling, transportation, or storage of any material, used on any street, road, parking lot, or operation of a construction site or demolition project unless reasonable precautions are taken to control emissions of airborne particles. Emissions shall not exhibit an opacity exceeding 20 percent or greater averaged over six consecutive minutes.

ARM 17.8.604 (Applicable) lists certain wastes that may not be disposed of by open burning.

ARM 17.24.761(2)(a), (e), (h), (j), and (k) (Applicable) requires that fugitive dust control measures be employed in reclamation operations.

4.7 NOXIOUS WEEDS (APPLICABLE)

Section 7-22-2101(7)(a), MCA defines "noxious weeds" as any exotic plant species established or that may be introduced in the state which may render land unfit for agriculture, forestry, livestock, wildlife, or other beneficial uses or that may harm native plant communities and that is designated: (i) as a statewide noxious weed by rule of the department; or (ii) as a district noxious weed by a board, following public notice of intent and a public hearing. Designated noxious weeds are listed in ARM 4.5.201 through 204 and must be managed consistent with noxious weed management criteria developed under § 7-22-2109(2)(b), MCA.

5.0 OTHER MONTANA LAWS

The following laws may apply to actions being conducted at the Spring Meadow Lake site. While not an exhaustive list, they are included because they identify related concerns that must be addressed and, in some cases, may require some advance planning. They are not included as ARARs because they are not "environmental or facility siting laws." As applicable laws other than ARARs, they are not subject to ARAR waiver provisions.

The administrative/substantive distinction used in identifying ARARs applies only to ARARs and not to other applicable laws. Thus, even the administrative requirements (for example, notice requirements) of

these laws must be complied with in this action. Similarly, fees that are based on something other than issuance of a permit are applicable.

5.1 MONTANA SAFETY ACT (APPLICABLE)

Sections 50-71-201, 202 and 203, MCA, state that every employer must provide and maintain a safe place of employment, provide and require use of safety devices and safeguards, and ensure that operations and processes are reasonably adequate to render the place of employment safe. The employer must also do every other thing reasonably necessary to protect the life and safety of its employees. Employees are prohibited from refusing to use or interfering with the use of safety devices.

5.2 EMPLOYEE AND COMMUNITY HAZARDOUS CHEMICAL INFORMATION ACT (APPLICABLE)

Sections 50-78-201, 202, and 204, MCA, state that each employer must post notice of employee rights, maintain at the work place a list of chemical names of each chemical in the work place, and indicate the work area where the chemical is stored or used. Employees must be informed of the chemicals at the work place and trained in the proper handling of the chemicals.

5.3 WATER RIGHTS

Section 85-2-101, MCA, declares that all waters within the State are the State's property, and may be appropriated for beneficial uses. The wise use of water resources is encouraged for the maximum benefit to the people and with minimum degradation of natural aquatic ecosystems.

Parts 3 and 4 of Title 85, MCA, set out requirements for obtaining water rights and appropriating and utilizing water. All requirements of these parts are laws which must be complied with when using or affecting waters of the state. Some of the specific requirements are set forth below.

Section 85-2-301, MCA, of Montana law provides that a person may only appropriate water for a beneficial use.

Section 85-2-302, MCA, specifies that a person may not appropriate water or commence construction of diversion, impoundment, withdrawal or distribution works therefore except by applying for and receiving a permit from the Montana Department of Natural Resources and Conservation.

Section 85-2-311, MCA, specifies the criteria which must be met in order to appropriate water.

Section 85-2-402, MCA, specifies that an appropriator may not change an appropriated right except with the approval of the DNRC.

Section 85-2-412, MCA, provides that, where a person has diverted all of the water of a stream by virtue of prior appropriation and there is a surplus of water, over and above what is actually and necessarily used, such surplus must be returned to the stream.

5.4 GROUNDWATER ACT

Section 85-2-516, MCA, states that within 60 days after any well is completed a well log report must be filed by the driller with the Bureau of Mines and Geology.

5.5 WATER WELL CONTRACTORS

37-43-301, MCA provides that any person who drills or otherwise constructs water wells must have a state licensed water well contractor in charge of construction.

ARM 36.21.403, 36.21.405, 36.21.406 and 36.21.411 provide requirements for water well contractors, contents of a water well contractor's license, and bonding requirements for water well contractors.

5.6 CONSTRUCTION STANDARDS

ARM 36.21.601 through 36.21.680 set forth water well construction standards.

5.7 OCCUPATIONAL HEALTH ACT OF MONTANA

The Occupational Health Act, §§ 50-70-101, MCA, are applicable protections for employees working at abandoned mine sites.

ARM § 16.42.102 establishes maximum threshold limit values for air contaminants for categories of workers.

